

SEPTEMBER 17, 1960

Chemical Week

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METAL ORGANICS

CW Report . . p. 52




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Aluminum makes
biggest gains among
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makers move hard
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◀ When alarm sounds.
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CW 100

ON THE COVER: Local fire department volunteers get inside look at Kay-Fries' W. Haverstraw, N.Y., plant during tour highlighting company's enterprising safety program.



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Chemical Week (including Chemical Specialties and Chemical Industries) is published weekly by McGraw-Hill Publishing Co., James H. McGraw (1860-1948), founder. EXECUTIVE, EDITORIAL, CIRCULATION AND ADVERTISING OFFICES: McGraw-Hill Building, 330 West 42nd St., New York 36, N. Y. Telephone, LO 4-3000; Teletype, TWX N. Y. 1-1636; Cable, MCGRAWHILL, N. Y. Place of publication: Philadelphia, Pa. Second class postage paid at Philadelphia. (See below for directions regarding subscriptions or change of address.) OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, president; Shelton Fisher, Wallace F. Traendly, senior vice-presidents; John R. Callahan, vice-president and editorial director; Joseph H. Allen, vice-president and director of advertising sales; A. R. Venezian, vice-president and circulation coordinator. OFFICERS OF THE CORPORATION: Donald C. McGraw, president; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, executive vice-presidents; L. Keith Goodrich, vice-president and treasurer; John J. Cooke, secretary.

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The Nation's Fastest-growing Chemical Complex is in KENTUCKY!

This is the fastest-growing chemical complex in the nation. Looking down from the airplane, you see more than \$100,000,000 in new chemical plants—which, by conservative estimates, will increase an average of \$10,000,000 per year in new construction for at least 10 years.

Yet Calvert City is still only the No. 2 producer of chemicals in Kentucky. Louisville outranks it, and Ashland is not far behind. In addition, other plants are being built each year in literally dozens of other cities and towns throughout Kentucky. According to a nation-wide survey by the Manufacturing Chemists' Association, Kentucky ranks *eighth* in the nation in actual and planned expenditures for chemical facilities for the period 1959-62. Completions in 1959 totaled \$20,866,000. M.C.A. says \$74,250,000 will be spent for chemical construction in Kentucky in 1960-61.

What are the reasons for this explosive chemical growth? Kentucky has boundless supplies of water and other natural resources such as coal, oil, natural gas, limestone, clays, sands, fluorspar, etc. Existing electric power plants easily supply all present needs; additional plants now planned or under construction will double present production in the next few years. And transportation advantages include favorable rail rates and great bargaining opportunities based on the fact that Kentucky has more miles of navigable rivers

than any other state. Above, you can see both the Tennessee and Ohio Rivers. And just five miles east is the mighty Cumberland River which will soon be impounded by Barkley Dam.

Last but far from least—our people, as individuals and through their local civic groups and state government, are working to improve their communities with better schools, streets, and municipal and cultural facilities. They are *eager* for the progress and opportunity inherent in industrial growth. These are not mere words—they are truths proved by the facts that Kentucky now offers more financing plans for new and expanding industries than any other state—has created the million-dollar Spindletop Research Center and Park at Lexington—has expanded the Kentucky Department of Economic Development to make it a foremost facility in its field.

We urge you to discuss your needs with this Department. You will be favorably impressed by the conservative, thorough and completely professional way in which we will try to be of help. Your inquiries will be held in strictest confidence. Address:

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Why You Pay for Chemical Week

"THE WAY TO SPREAD A WORK is to sell it at a low price. No man will send to buy a thing that costs even sixpence, without an intention to read it." Dr. Samuel Johnson, the English author and lexicographer, said that about 200 years ago, and it is no less true today. It is the basic philosophy underlying Chemical Week's commitment to paid circulation—a commitment shared by all McGraw-Hill magazines and those of many other, but by no means all, publishers.

The economics of magazine publishing is anomalous in that the recipient of the product doesn't provide the profits of the enterprise. Those are provided by the advertisers who seek to reach the magazine's audience. Thus it would be possible to give away the magazine, as some publishers do, and let advertising income pay all costs and provide the profit. There are many reasons why we don't.

First of all, income from your subscriptions—even though it is a small proportion of total income—helps maintain an adequate editorial staff, which now numbers 40 people. Loss of that income would necessitate higher advertising rates or curtailed editorial service.

Second, we believe with Dr. Johnson that you won't pay for Chemical Week unless you intend to read it. Conversely, if you find it unprofitable to read, you won't renew your subscription. This is an effective goal to editorial excellence, since we must constantly strive to meet your needs more effectively. (Incidentally, Chemical Week today has more subscribers than ever, and a higher renewal percentage than ever.)

Third, paid subscriptions assure a "live" audience. If you should die, retire, move, or change your job, the fact comes automatically to our attention.

If you are an advertiser, you want to know more than the fact that we have 43,670 subscribers. You want to know who they are—whether they are the kind of people who can buy your product. You want to know their jobs, for what companies they work, where they are. Many years ago you simply had to take the publishers' word for it—and occasionally the word was false.

That's why advertisers, advertising agencies, and publishers of newspapers and magazines got together back in 1914 to set up an impartial, independent fact-finding body, the Audit Bureau of Circulations. Its auditors visit every magazine publisher once a year to comb through his circulation lists and verify the facts.

"So what?" you as a reader may well be asking. "What's all this to me?" Simply this. Advertisers are more willing to buy space for their message if they can be sure of the audience they're reaching, and it is their money that underwrites the editorial service you receive. Without it, we would have to charge you at least 15 times as much for your annual subscription. Even though Chemical Week is useful to you, you wouldn't relish paying \$50 a year for it. That's why you, as well as we, owe a vote of thanks to Audit Bureau of Circulations during this ABC month.

CHEMICAL ISOLATION

SPEED OF ACTION and high purity of product distinguish the two different processes for chemical isolation on the next page.

In the first, a synthetic organic flocculant shows dramatic speed on a wide range of materials. The second is a petroleum extraction process yielding aromatics of extremely high purity.

ACTION OF SEPARAN® organic flocculant is illustrated above. (Separan flocculant is a high molecular weight polymer of acrylamide with some replacement of amide by carboxylic groups.) The molecules of the flocculant are represented as long chains containing numerous highly active sites. These sites have a high affinity for solid surfaces. Initially some active groups of the molecule attach themselves to the solids with a larger portion of the molecule extending into the solution. Agglomeration then begins in two ways—by bonding between the active groups of two separate molecules on different particles, or by the attachment of a molecule from one particle directly onto a second particle. Although this “bridging” is the major flocculation mechanism, Separan also tends to reduce the zeta potential (an expression of the electrical repulsion between particles).

FLOCCULATION

SYNTHETIC FLOCCULANT SHOWS WIDE-RANGE EFFECTIVENESS, SPEED

Separan NP10 flocculant is remarkably effective on a wide range of suspensions, from solids in river water to minerals and chemical precipitates. It is effective even when the suspending solution is strongly acidic or basic, or of high solids content. Particles ranging from colloidal clays to coarse sands are flocculated by this material.

Leaching operations create some of the most difficult liquid-solid separations encountered in the mining industry. Separan NP10 is used on leached zinc calcines prior to the electrolytic refining and recovery of zinc. It is used in the neutral or primary leach thickeners as well as in a number of thickening applications during the purification of the zinc electrolyte. In one large refinery, one to two pounds per day has made it possible to replace two to three men and to eliminate one filter press operation in the zinc solution purification step.

Separan NP10 is used in uranium mills to thicken the ore

pulp before leaching, to flocculate both acid- and carbonate-leached pulp, and to flocculate high grade precipitates. Many plants have increased the capacity of existing operations several times through the use of Separan NP10. In one installation, use of Separan NP10 allowed the elimination of four thickeners, six out of seven filters, and two settling ponds. As a result, the operating costs at this location were lowered by \$3000 a day.

The paper industry, too, has realized significant savings by using Separan flocculants for: filler retention, process water clarification, improved save-all operation, and clarification of white and green liquors.

Separan flocculants are generally adaptable to any operation which involves an aqueous liquid-solids separation such as thickening, clarification, and filtration. Examples include the production of alum, borax, phosphoric acid, magnesium, and the general area of industrial waste and water treatment.

EXTRACTION

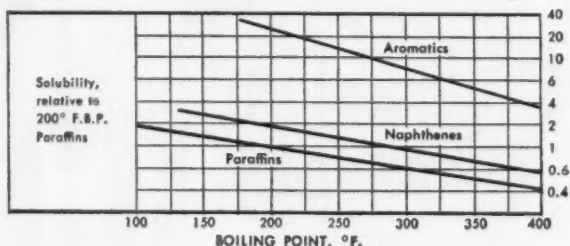
ECONOMICAL UDEX PROCESS ENABLES BOTH LARGE AND SMALL REFINERS TO ENTER PETROCHEMICAL FIELD

Udex process, originated by Dow and developed for licensing by Universal Oil Products, is a selective liquid/liquid solvent extraction method for the separation and fractionation of aromatics from hydrocarbon mixtures. Extremely high product purity is obtained based on the solubility and selectivity differences between paraffins and aromatics in glycol solvents. Quality of the recovered benzene, toluene, and xylenes is of such high purity that in most cases the product will meet the specification for solvent grade material without further processing. Udex products usually exceed ASTM nitration-grade specifications.

The extraction solvents are Udex® brands of diethylene glycol, triethylene glycol, or dipropylene glycol, depending on the desired end product or feed-stock composition. These Udex polyglycols are high purity solvents developed specially by Dow for use in the Udex process. So selective are these solvents that several aromatics can be extracted simultaneously at high purity levels. Reduced utility requirements also result from the high boiling point of the glycols. This

allows direct distillation of the aromatics from the solvent. The glycols are noncorrosive, non-toxic, stable, relatively inexpensive, and readily available.

Octane improvement is a continuing problem for refiners who must constantly upgrade gasoline to meet higher octane requirements. A number of Udex units are used to extract aromatics from petroleum fractions. These aromatics are then blended into gasoline to boost the octane rating.



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September 17, 1960 CHEMICAL WEEK 7

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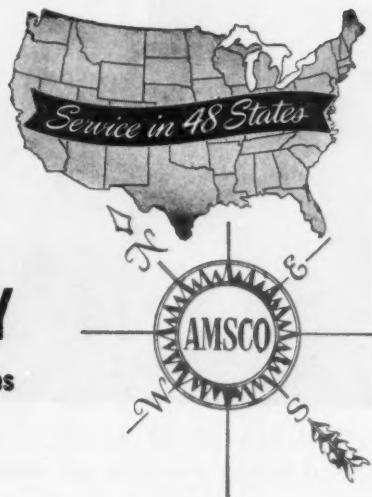
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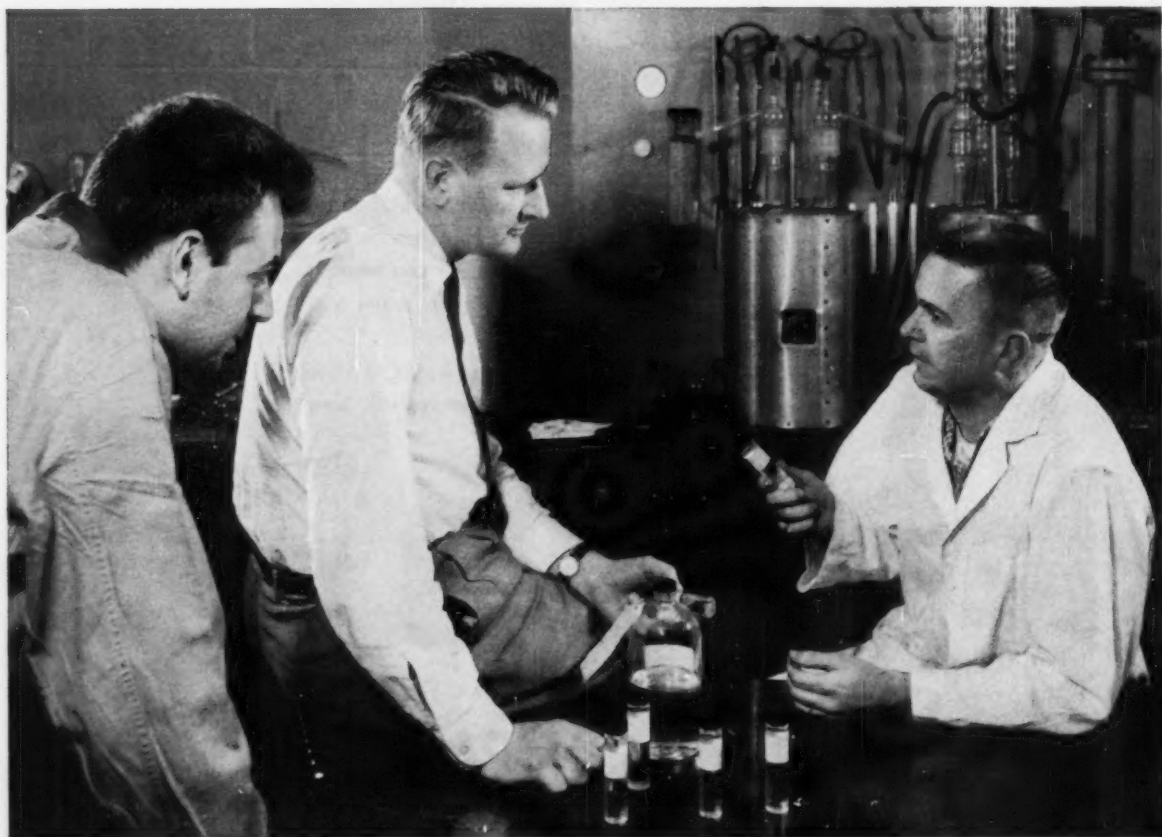


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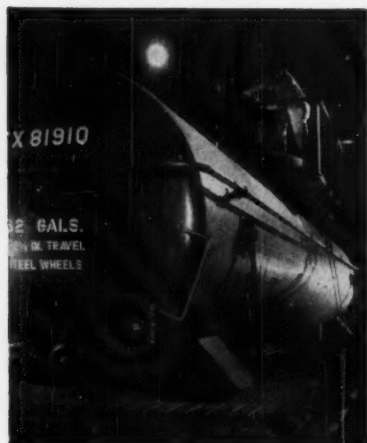
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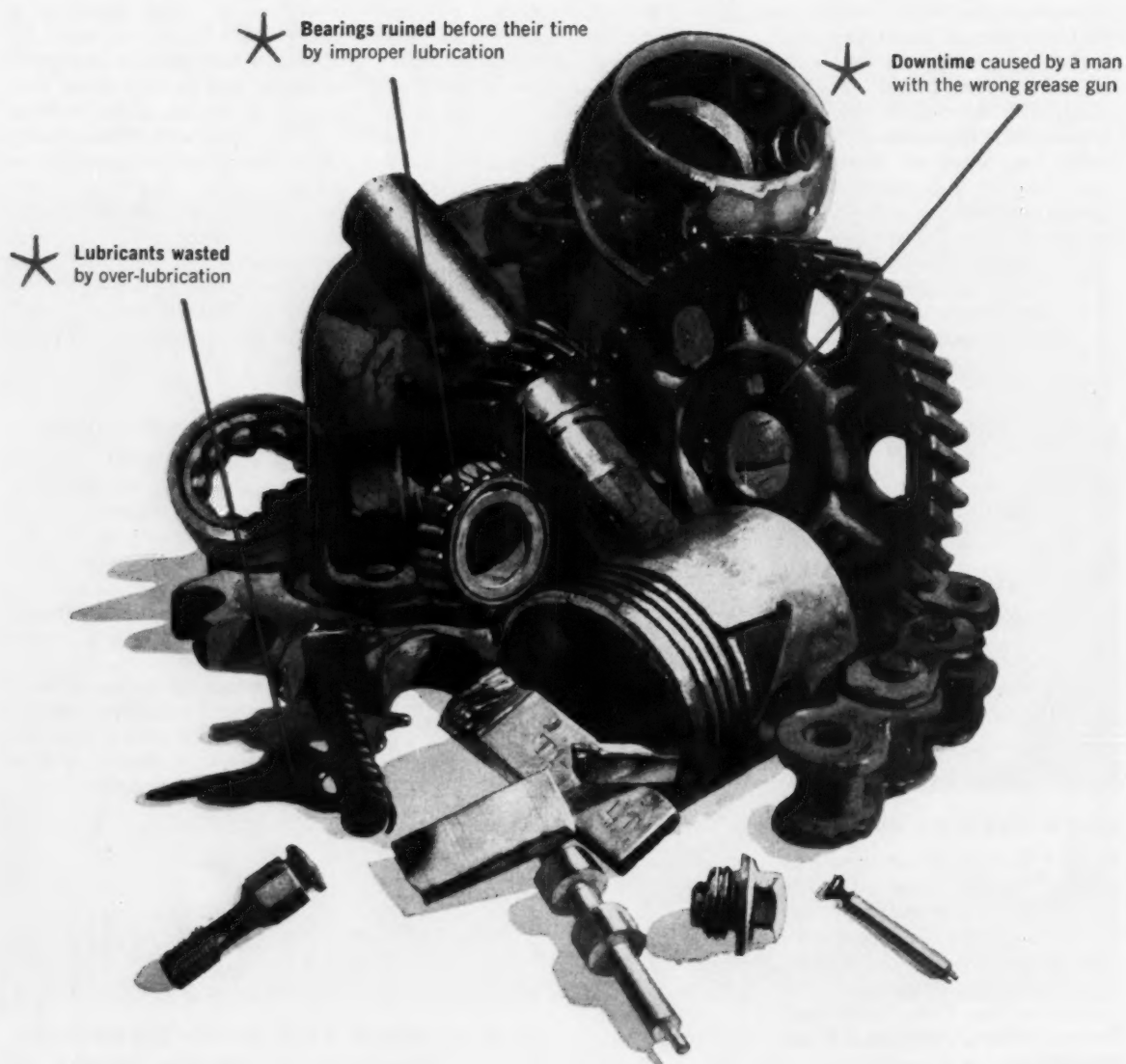
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September 17, 1960 CHEMICAL WEEK 11

ANNOUNCING THE TEXACO "Stop Loss" Program

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by improper lubrication

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with the wrong grease gun

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by over-lubrication

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

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If yours is an average chemical plant, the adoption of this program will actually show up on your profit sheet. That's because the savings from "Stop Loss" go *directly* into net profits.

Lubrication, far from being an expense item, is actually one of your most effective cost control tools!

HERE'S WHAT YOU NEED TO HELP STARVE YOUR SCRAP PILE

These components of the Texaco "Stop Loss" Program are available to interested plant groups:

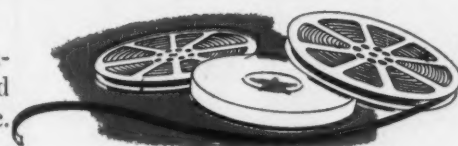
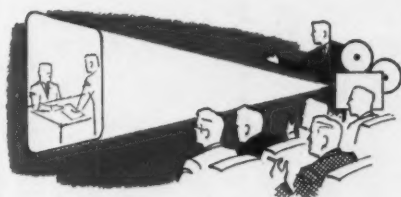
1. New 20-minute sound-color film "Stop Loss with Organized Lubrication"—created to show the many opportunities for cost control through organized lubrication practices.

2. A Lubrication Control System that takes the guesswork out of lubrication scheduling. It costs almost nothing to install, yet can save as much as 15% of your maintenance costs.

3. A film "package" for various departments. This consists of educational films that cover the selection and application of greases, hydraulic oils, cuttings oils, etc.

4. Co-ordinated booklets on the film subjects plus many others that can be used as guides in specific areas.

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Title _____

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Dust *isn't* a must with polyvinyl alcohol

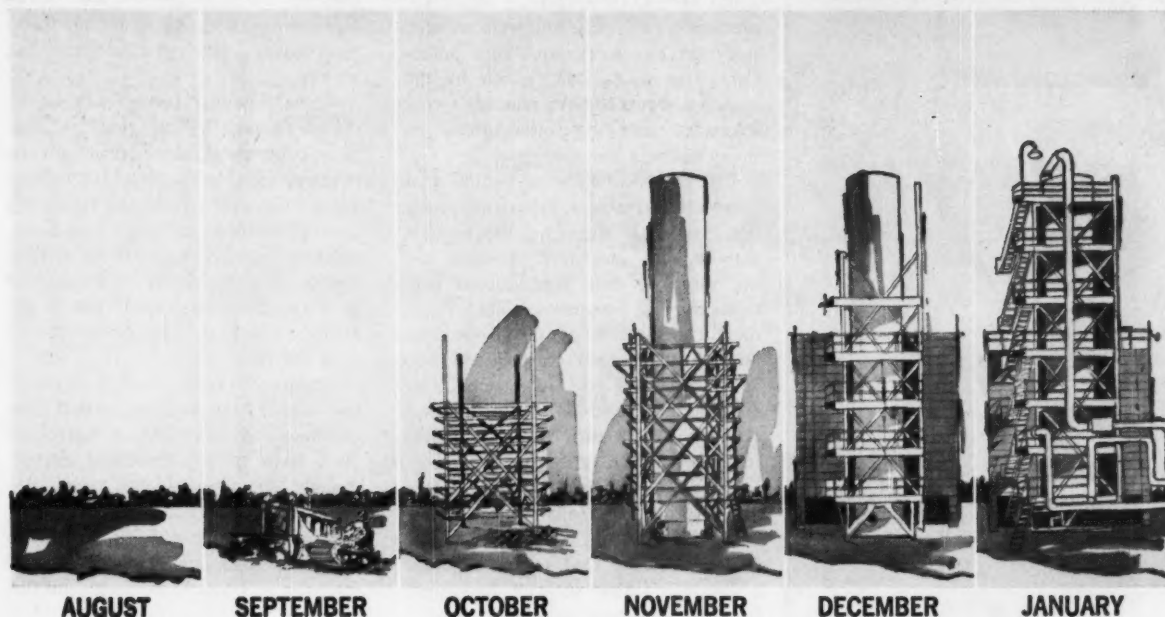
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Springfield, Massachusetts

CHEMICO BUILDS NITRIC ACID PLANT IN SIX MONTHS



It took just six months for Chemico to successfully complete a 120 ton per day nitric acid plant in Lawrence, Kansas. Until the client gave his final "go-ahead," not an hour of drafting or engineering had been done on the project—not a single piece of equipment had been placed on order. Yet, six months from that date, the plant finished its acceptance test run, producing at above rated capacity.

With 34 nitric acid plants in operation all over the world, and three more in the design stages at this very time, Chemico maintains its position of leadership in this field. In building plants to produce Ammonia, Urea, Nitric Acid, Acetylene, Methanol, Hydrogen, Sulfuric Acid and other chemical and petrochemical products, Chemico is setting new standards for the entire engineering industry.

This six month performance for a nitric acid plant follows closely the recent successful completion of an ammonia plant in ten months. It is not just the time factor alone which sets Chemico plants apart, however. Chemico clients know that they are buying efficient, economical, proven processes which assure ease of start-up and simple, safe operation. If you are considering building a new plant or enlarging present process facilities, let Chemico help you get the most for the capital you invest. Write for the General Bulletin which describes the wide range of Chemico's activities.

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September 17, 1960 CHEMICAL WEEK 15

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LETTERS

Nature's Zeta Potential

TO THE EDITOR: I very much appreciate your concise and well-rounded story on our work with zeta potential (*Aug. 6, p. 26*), which by the response seems to have reached a very interested and inquisitive group in many fields of chemistry.

Lest anyone be led to believe that zeta potential is new, I hasten to state that nature, through biochemical activity, has employed it since the beginning of time for aqueous precipitation of organics. The fundamental principles of electro-osmosis and electrophoresis were noted 100 years ago, with real advancement by Helmholtz around 1878, Von Smoluchowski at the turn of the century; the New Yorker, Abramson, around '32; Tiselius of Sweden and Verwey and Overbeek of Holland, and others, from about '42.

It is amazing that so fundamental a principle—now so well developed from a theoretical standpoint—could be neglected for so long by those engaged in industrial fields where either precipitation or dispersal are really important. It is likely that this was due to lack of a cell that could be expeditiously handled by the average technician, and to the condition that prior to the publication of Mycels' "Introduction to Colloid Chemistry" (*Interscience*—'59) there were few texts to bridge the introductory gap to the publications of Verwey, Overbeek and Kruyt—which, though basic, are sophisticated.

Whether one correctly thinks of zeta potential as a great or a tiny force depends wholly upon particle size. Two 10-ton boulders plainly evidence the tremendous force of gravity if one tries to move them. If they are suspended and submerged in a lake, however, they surely would have zeta potential and exert an electronegative and mutually repelling force—though of completely insignificant and immeasurable proportions. This relationship would also obtain for two 1-millimeter grains of sand dropped side by side into the lake water. However, if these same two sand particles are finely ground in a mortar, the zeta potential of their fragments is (together with the minor forces) capable of sufficient mutual repulsion to cause them to remain suspended indefinitely, despite the relatively high specific gravity of silica

(2.65). The gold sols of Arrhenius are still suspended. In the size category of 10 angstrom units to about one micron, the zeta potential, therefore, exerts a much greater force than gravity.

These repelling forces may be reduced to zero by bringing the relative concentration of positive and negative ions at the outer surface of the double layer to equality with ionic concentration in the bulk of the suspending liquid. Agglomeration then results in a buildup of particle size to a range where Stokes' law is applicable—and the force of gravity does the rest.

Apparently most manufacturers of surfactants have never evaluated their cationic and anionic polyelectrolytes on a basis of zeta potential change, though undoubtedly this effect (together with change in surface tension) is highly significant. The cationics have, of course, been widely employed to give a soft feel to textiles—and this effectiveness is to some extent tied in with length of polymer chain, and the like. We are now engaged in evaluating a number of cationics on a basis of cost per unit change of zeta potential. The variations are tremendous, and there seems to be no relationship between this and cost per pound, percent active ingredients, or even type of polyelectrolyte. The zeta potential must eventually be taken into full account if realistic comparisons of either effectiveness or costs are to be made.

Also, you seem to have complicated my technique by substituting a "spectroscopic" for the "stereoscopic" type of microscope—mandatory for this type of electrophoresis cell. The theory of zeta potential is complex enough without adding the intricacies of spectroscopy.

THOMAS M. RIDDICK
Thomas M. Riddick & Associates
New York

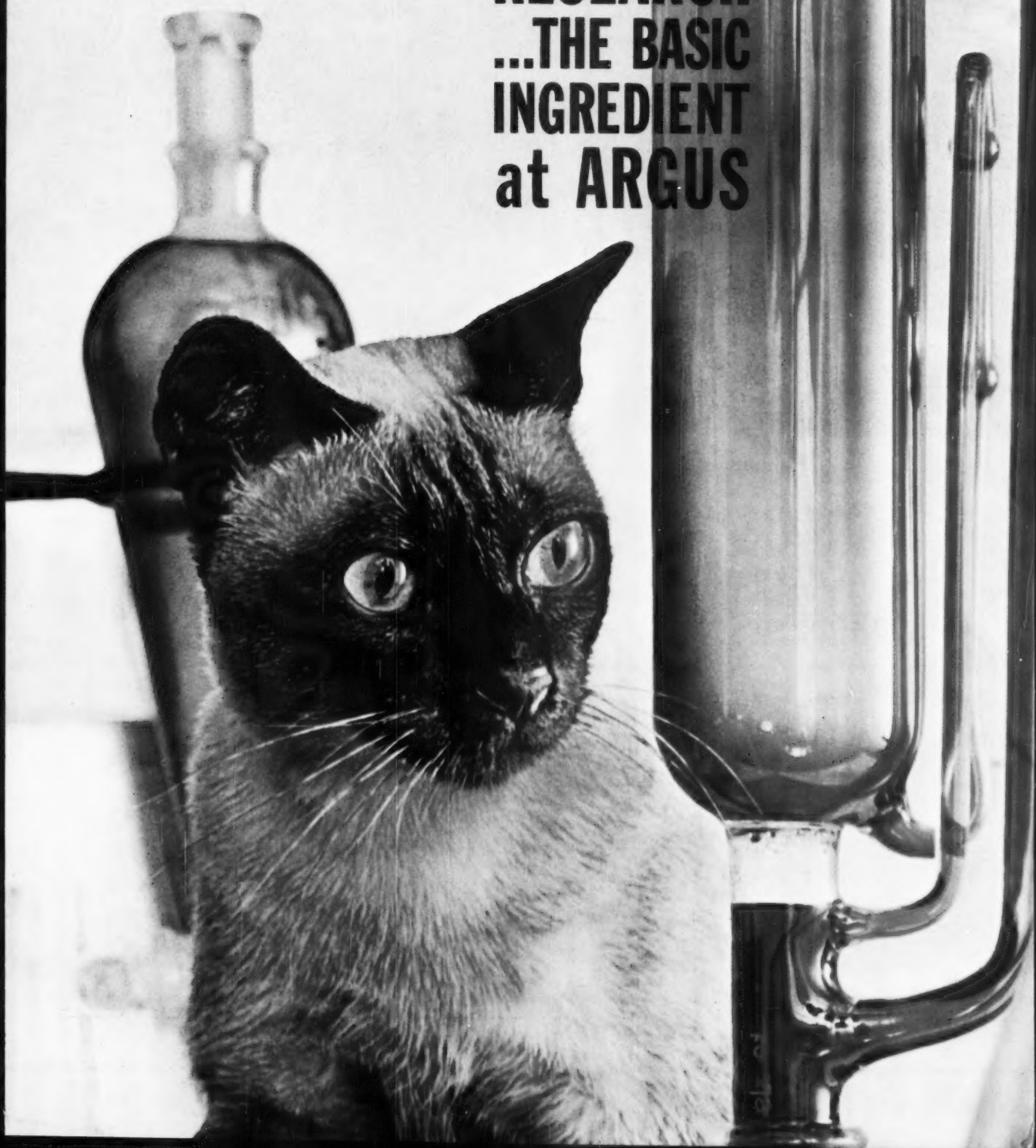
MEETINGS

Chemical Market Research Assn.: theme: "The European Chemical Industry"; Wentworth-by-the-Sea, Portsmouth, N. H., Sept. 22-23.

American Ceramic Society, electronics division meeting, Schroeder Hotel, Milwaukee, Wis., Sept. 22-23.

American Institute of Chemical Engineers, national meeting, Mayo Hotel, Tulsa, Okla., Sept. 25-28.

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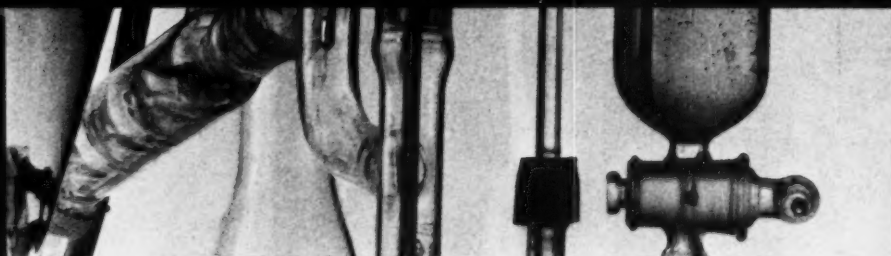


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DRAPEX PLASTICIZERS*			MARK STABILIZERS																							
			LIQUIDS												SOLIDS											
DRAPEX 3.2	DRAPEX 4.4	DRAPEX 7.7	MARK M	MARK LL	MARK KCB	MARK PL	MARK GS	MARK XV	MARK C	MARK XX	MARK DNY	MARK X	MARK A	MARK XI	MARK TT	MARK WS	MARK E	MARK JR	MARK IO	MARK HH	MARK 225	MARK 33	MARK 34	MARK 35	MARK 99	

* Drapex 6.8, an epoxy soya, now on stream also.

The characteristics of Argus Mark Stabilizers and Drapex Plasticizers are described on the following page.





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MARK KCB Barium-cadmium-zinc complex. Recommended for resistance to sulfide staining. Also gives outstanding heat stability to all vinyl compounds highly filled with calcium carbonate, regardless of resin choice.

MARK PL Zinc-containing complex. Exhibits a synergistic action on stability and provides high resistance to sulfide staining, when used with other Mark stabilizers.

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MARK XV Cadmium-containing chelating agent. Markedly improves the heat and light stabilizing action of lead, barium, calcium and strontium stabilizers. Recommended as sole stabilizer for applications requiring light stability and crystal clarity.

MARK C Most efficient chelating agent developed. Used with barium-cadmium systems, it improves heat stability, provides crisper color and superior clarity. Specifically recommended for compounds containing high amounts of phosphate plasticizers.

MARK XX Antioxidant or chelating agent. Increases the efficiency of a saturated metallic soap or a metallic salt.

MARK DMY Chelating agent. Developed specifically for applications requiring extreme long-term stability.

MARK X & MARK A Alkyl tin mercaptides. Specifically recommended for stabilizing crystal-clear unplasticized compounds and certain European emulsion polymerized resins which may be difficult to stabilize with conventional barium-cadmium stabilizers.

MARK XI Coprecipitated barium-cadmium laurate. Provides excellent heat and light stabilization. Also, used with Mark M or LL, it is recommended for stabilizing compounds containing more than five parts of a phosphate plasticizer.

MARK TT Barium-cadmium soap, generally interchangeable with Mark XI. Recommended for stabilizing high-phosphate formulations as well as all general purpose vinyl applications. Gives excellent heat stability.

MARK WS Barium-cadmium complex. Most powerful stabilizer available. Recommended where an exceptional degree of long-term stability is required.

MARK E Strontium-zinc laurate. Gives complete freedom from sulfide staining. Has a very low degree of toxicity.

MARK JR & MARK JO Barium-zinc complexes for the stabilization of highly filled compounds such as floor tiles, cove moldings, etc. Provide complete freedom from sulfide staining. Non-lubricating, they do not hinder processing.

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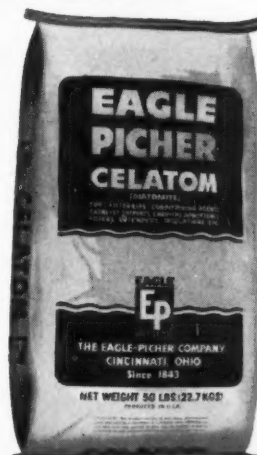
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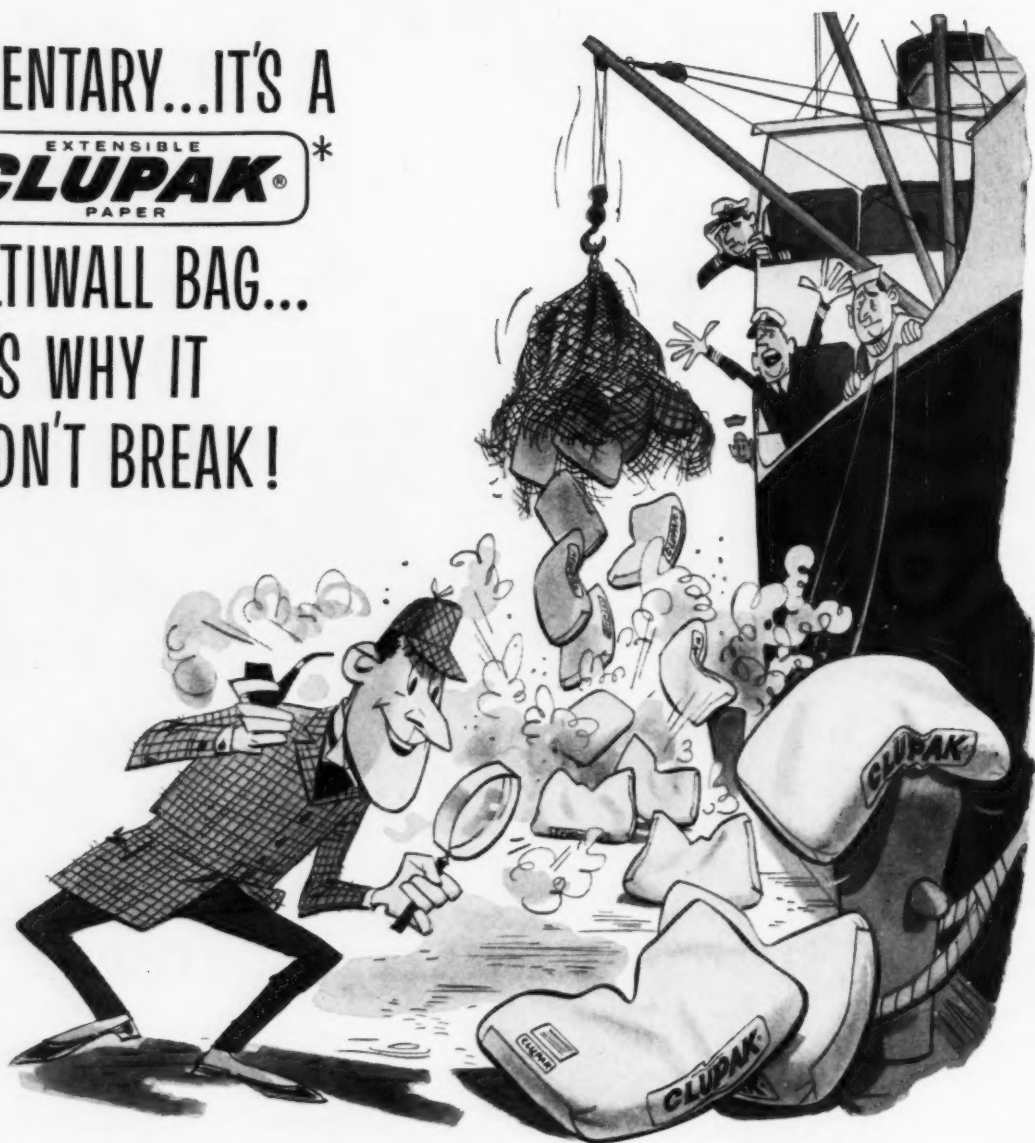
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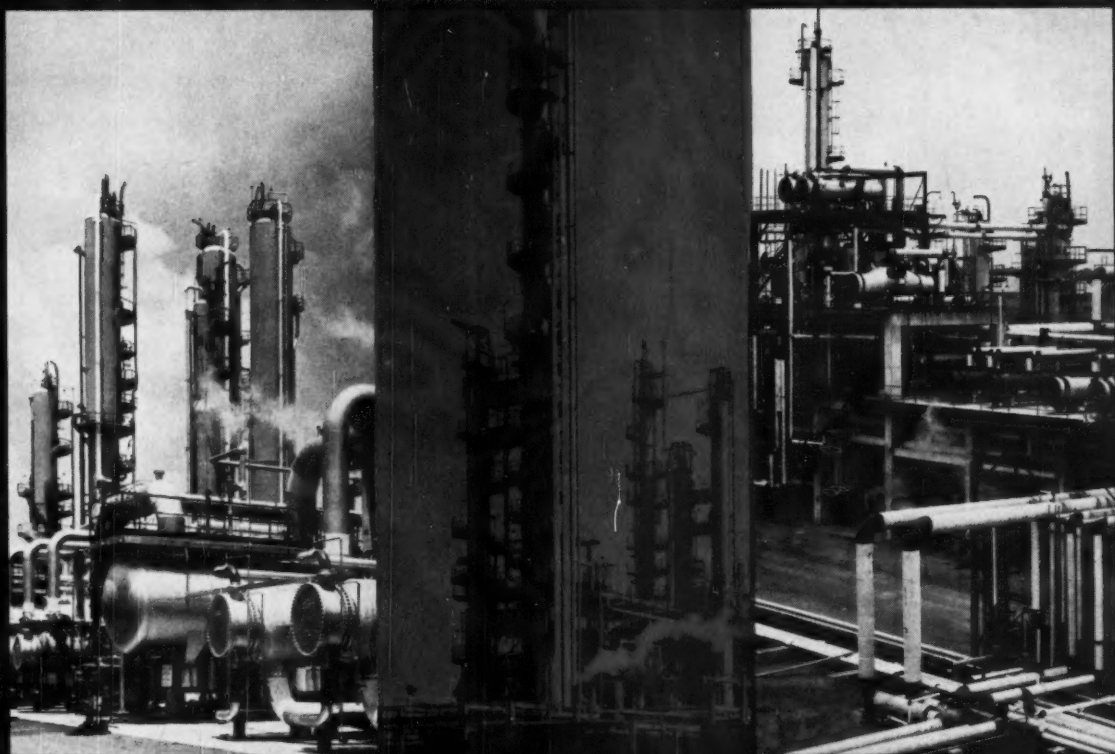
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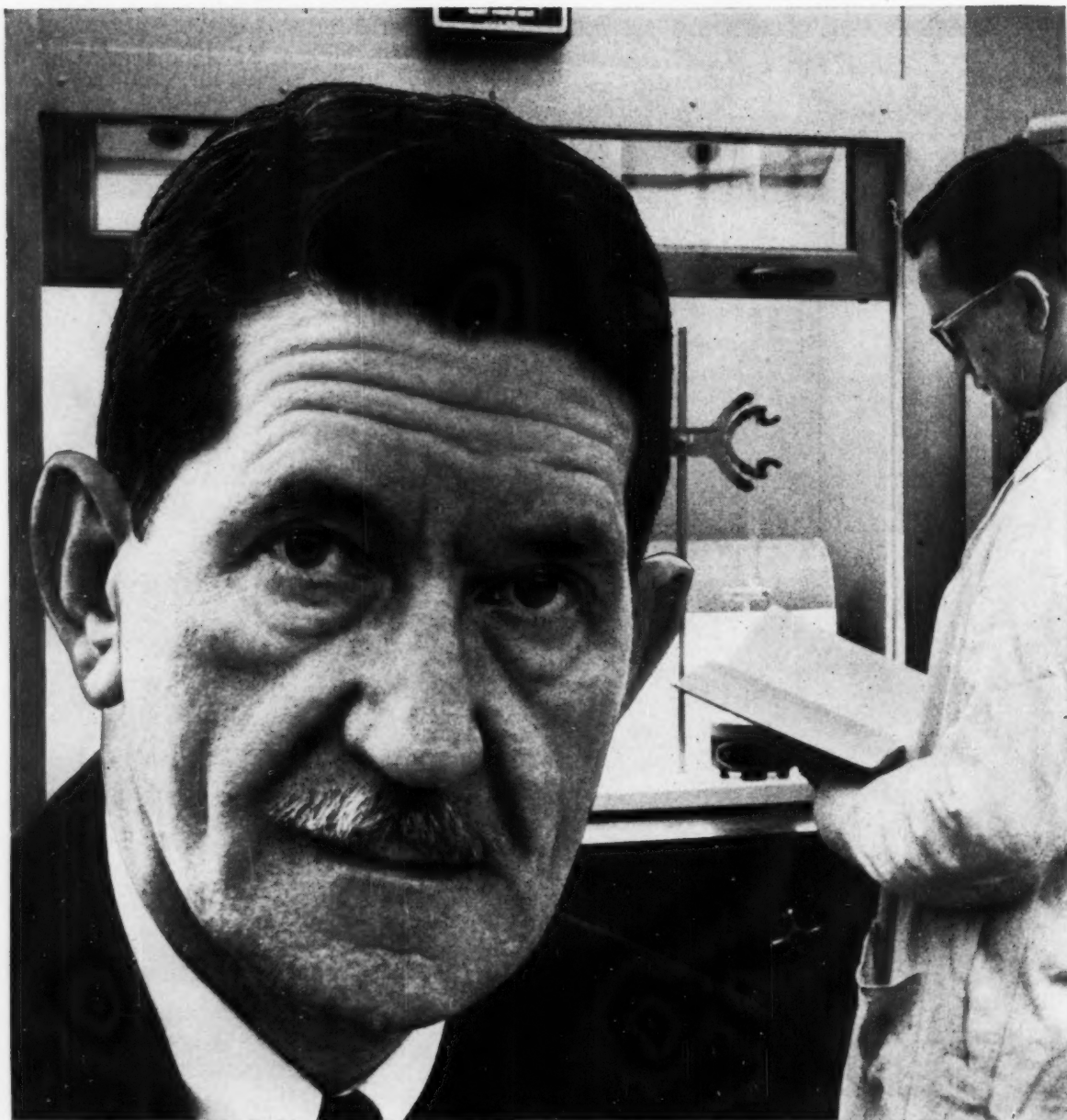
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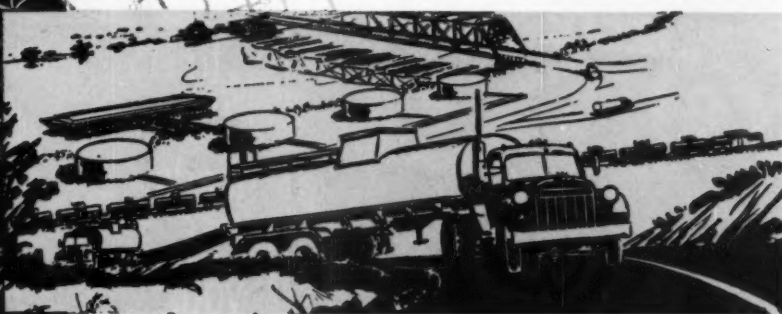
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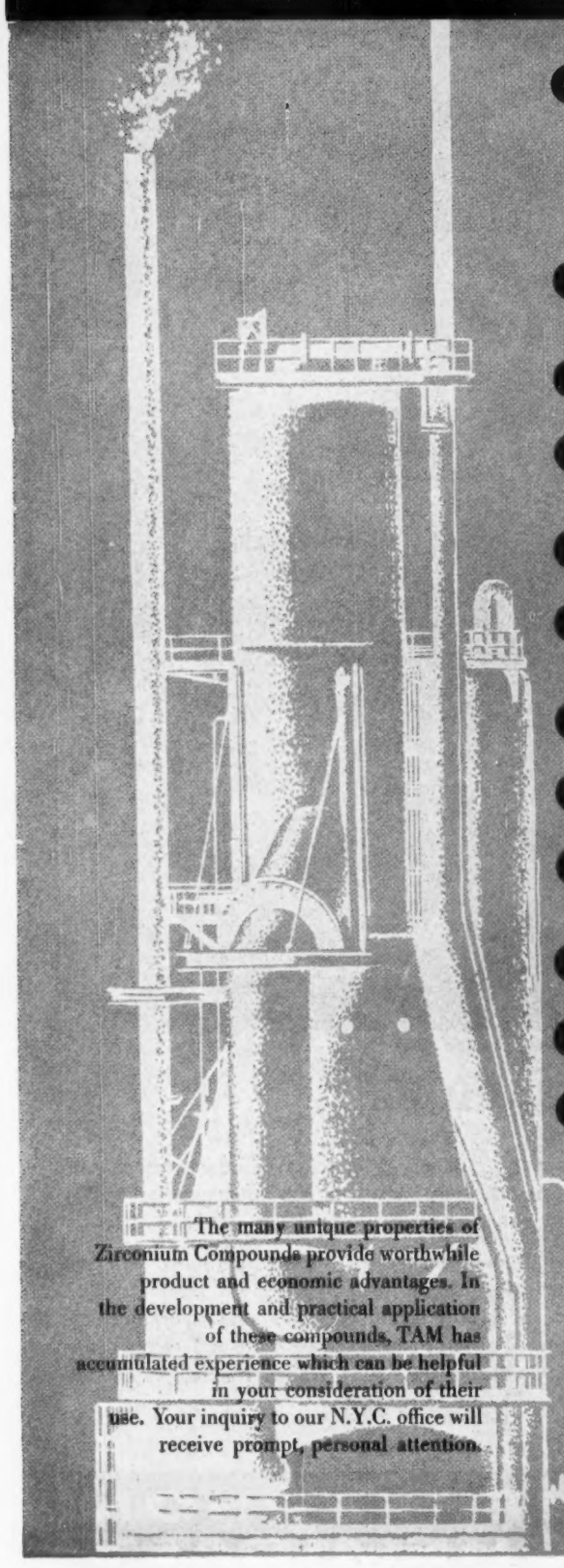
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**JEFFERSON
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Business Newsletter

CHEMICAL WEEK

September 17, 1960

Benzene from petroleum is the big expansion news this week.

South Hampton Co. (Silsbee, Tex.) has just put onstream the first Hydeal unit licensed by Universal Oil Products; benzene capacity is given as 4-6 million gal./year.

And four companies are building new or enlarged petrobenzene plants. Humble Oil & Refining will boost benzene capacity at Baton Rouge, La., to 24 million gal./year—a 60% increase. Plymouth Oil (Pittsburgh) plans to install a \$2-million Hydeal unit to produce up to 15 million gal./year at Texas City, Tex. Imperial Oil (Toronto) will put up a \$5-million benzene plant at Sarnia, Ont., with 30-million-gal./year capacity. And British American Oil will build a \$2.5-million Udex benzene extraction plant at Montreal East.

Add two more U.S. ventures in Europe. El Paso Natural Gas Co. plans to join Cie. Francaise de Raffinage in a joint venture to build a 20,000-metric tons/year low-density polyethylene plant near Le Harve. It's due onstream early in '63.

Ethylene will come from Francaise de Raffinage's nearby refinery, which will expand ethylene capacity to more than 80,000 metric tons/year.

And Witco Chemical Co. and U.S. Rubber will build an \$8-million-lbs./year, \$2.5-million plant in England to produce butadiene-styrene, nitrile, and acrylic rubber latexes. It will be a 50-50 venture.

•
Cutter Laboratories' loss of its appeal on the Salk polio vaccine suits before the California supreme court (*CW*, Feb. 21, '59, p. 111) could establish a new legal principle—at least in California. The court upheld, without comment, a decision of a lower state court that Cutter, although not itself negligent, violated an "implied warranty" in selling vaccine to children who later contracted polio (much medical opinion holds that the cases of polio involved were allergic). Implication is that pharmaceutical makers might be held liable for any sickness caused by their products. But since the suit is based on a California legal precedent that is not generally followed in other states—that any product designed for human consumption carries an implied warranty to the consumer—the decision probably won't have a national effect.

•
Du Pont-Technicolor color film agreement rumors have been denied, but Du Pont admits it has been looking into the color film business (as the industry has been aware for 10 years). Film-making companies suspect Du Pont is looking at a positive-negative film to compete with Eastman's Kodacolor. Du Pont says it has talked to Technicolor, a Hollywood, Calif., color film processing firm that for the past five years has been threatening to market its own color film.

Business Newsletter

(Continued)

Quickening Technicolor's interest is its awareness of market gains being made by rival processor Dynacolor (Rochester, N. Y.), which is making a color film for private-label marketing by Walgreen drugstores and is planning to broaden sales under its own name. Du Pont says it may, if it decides to go into color, do its own marketing, but that a decision is at least a year away.

Polypropylene is making more strides abroad. In the Netherlands, Royal Dutch/Shell and Montecatini have set up a joint subsidiary, N.V. Rotterdamse Polyolefinen Maatschappij, to build and operate in Rotterdam a "large-scale" (estimated by trade observers at about 10,000 tons/year) polypropylene plant. The parent companies will have 60% and 40% equity, respectively. "First-phase" output will be used for plastics; plans apparently are open on further expansion for making monofilament and staple fibers. The Shell group will handle sales, restricted "for the time being" to the Benelux area.

Europe's polypropylene capacity is surging. In Britain, Imperial Chemical Industries plans to put its 10,000-ton/year plant onstream this year at Wilton—ahead of schedule, and Shell plans to start up its 30,000-ton/year polypropylene-polyethylene plant early in '61. In Germany, Chemische Werke Huels is expanding its small polypropylene plant from an estimated 4.5 million lbs./year to possibly as much as 10 million lbs., and Farbwerke Hoechst is doubling capacity of its 8,000-ton/year plant. In France, both Pechiney and Societe Normande are building 10,000-ton/year plants. In Austria, the 5,000-ton/year Montecatini-Danubia joint venture will be onstream by November. And in Italy, Montecatini's new Brindisi plant will bring its capacity in that country to 30,000 tons/year.

Trade talk is buzzing in Europe. In Geneva the members of GATT—the General Agreement on Tariffs and Trade—are meeting for some logrolling before the real tariff-cutting bargaining starts in January. Main topic of the current sessions is the expected effect of the European Common Market's tariffs on outsiders. For the first time, U.S. negotiators are optimistic on chances of getting more concessions than they give—particularly on chemicals. In the background of the Geneva session, informal talks are expected to be held between representatives of the Common Market and its rival trade group, the Free Trade Assn., over ways to heal their split.

Meanwhile, chances for finding such a solution, as well as for continuing the Common Market's unity, were dimmed by President Charles de Gaulle's press conference last week, in which he brought out into the open (though still in vague terms) his idea of building a European "Third Force" independent of the U.S., and of removing political decision-making from the Common Market's Commission (*CW*, Aug. 27, p. 41).



This news bulletin about Wyandotte Chemicals services, products, and their applications, is published to help keep you posted. Perhaps you will want to route these and subsequent facts to interested members of your organization. Additional information and trial quantities of Wyandotte products are available upon request . . . may we serve you?

WYANDOTTE ADDS NEW SERIES OF TETROLS...

Adding to the number and range of its intermediates for urethanes, Wyandotte has developed a series of polyether tetrols. The general name for the new series is Pluracol® PeP.

Three grades are available now in commercial quantities . . . Pluracol PeP 450, with an average molecular weight of 400; Pluracol PeP 550, with an average molecular weight of 500; and Pluracol PeP 650, with an average molecular weight of 600. All members of the series have four secondary hydroxyl groups, each joined to a central carbon atom by an oxyalkylene chain.

These new tetrols were developed specifically for use in urethane foams, elastomers, and coatings. All of them may be used in the preparation of quasi-prepolymers, as cross-linking agents, or in one-shot systems. If their properties suggest potential applications to you, get in touch with us . . . samples are available. And if you can furnish details, we'll supply data directly pertinent to your requirements. To assure prompt attention, address inquiries to Department C0.

AND NEW TRIOL...

Combining low molecular weight (300-320), low equivalent weight, and trifunctionality . . . Wyandotte's new polyether triol, Pluracol TP 340, increases cross-link density in urethane formulations. It may be used in the preparation of prepolymers, as a cross-linking agent, or as a polyol reactant in one-shot systems. Its effect is to increase rigidity, heat resistance, and solvent resistance in urethane foams, coatings, and solid polymers. For data that applies to your particular requirements, write Department C0. Samples for laboratory evaluation are available.

...TO LINE OF URETHANE-GRADE POLYETHERS

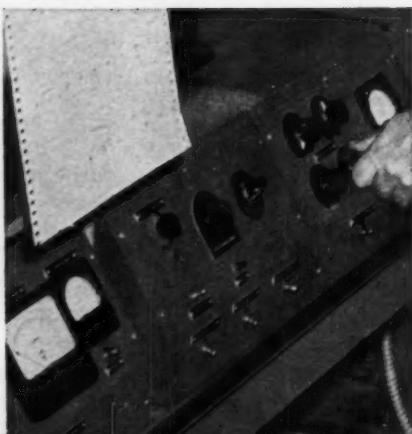
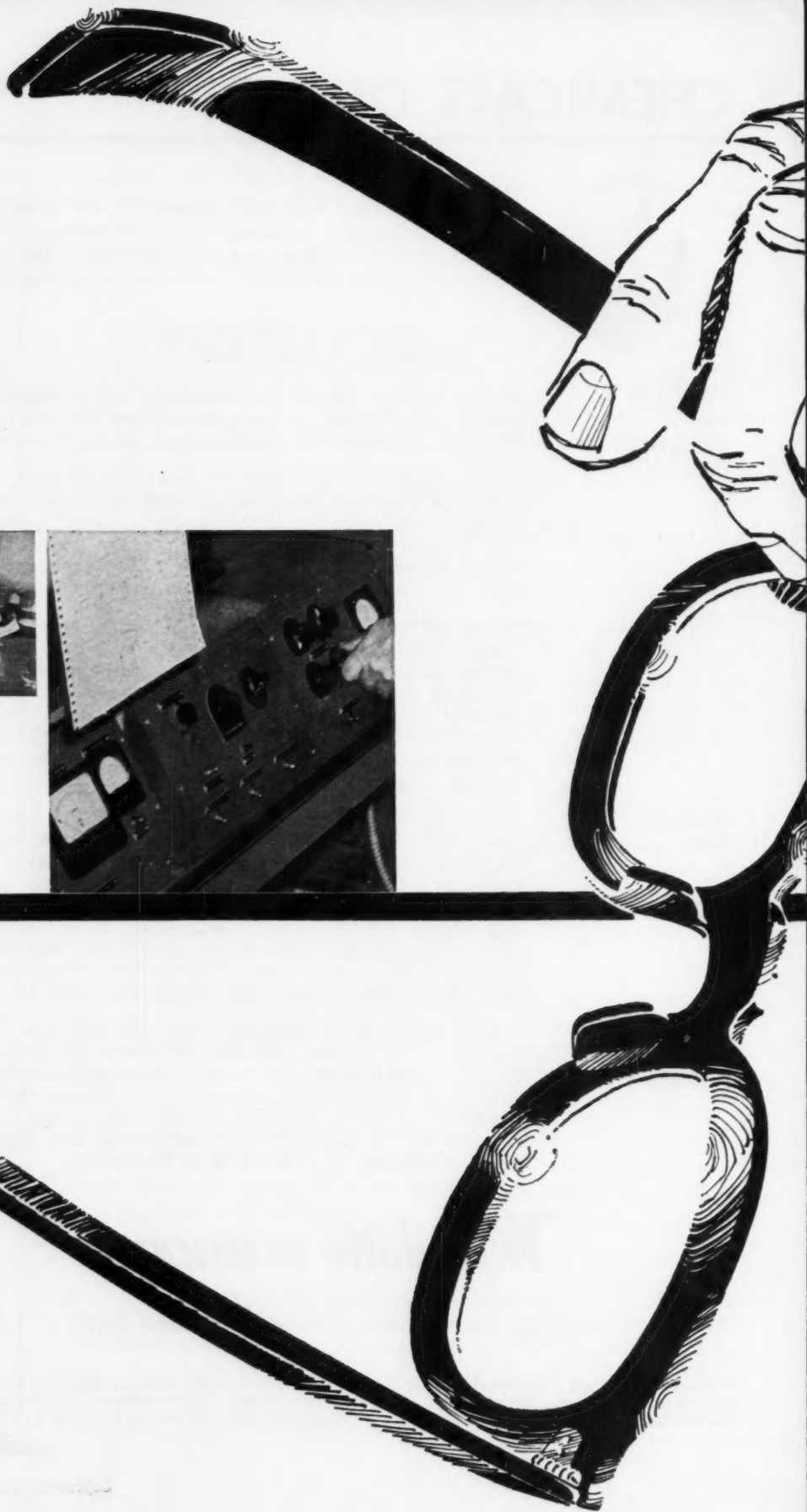
Our urethane foam intermediates include five additional Pluracol triols . . . TP 440, TP 740, TP 1540, TP 2540, and TP 4040. We also offer Pluracol Diols for prepolymer-type flexible foams; Tetronic® polyols for improved resilience and moldability; Quadrol®, a very reactive cross-linking agent and catalyst; and DHP-MP, a catalyst with extremely low odor. If you work with urethanes, may we work with you?

Wyandotte CHEMICALS

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FOR MORE NEWS
FROM WYANDOTTE





"security" clearance

Take all possible care to control the quality of chlorine and caustic up to the point of shipment. Follow proper loading procedures to the letter. Then go one step further . . .

At Wyandotte, this means putting a sample from each tank-car shipment of chlorine or caustic through a battery of exacting tests, as a "security" clearance.

These samples are subjected to qualitative and quantitative analyses. They measure up, or the car doesn't go out.

Few samples fail to clear this final check.

The steps that precede it provide virtual assurance of quality. But because the possibility, however remote, exists . . . we feel that the practice is warranted.

Dependable quality is a point of pride at Wyandotte. So is dependable service. Significantly, both of our chlorine-caustic plants are on major waterways to gain the advantage of low-cost water transportation. At Geismar, in the South, we are on the Mississippi . . . and close to the Gulf. At Wyandotte, in the North, we are on the Detroit River, and have direct access to the Great Lakes and the St. Lawrence Seaway. Railways and highways also go out from these two plants to four-fifths of the productive capacity of the U.S. and Canada.

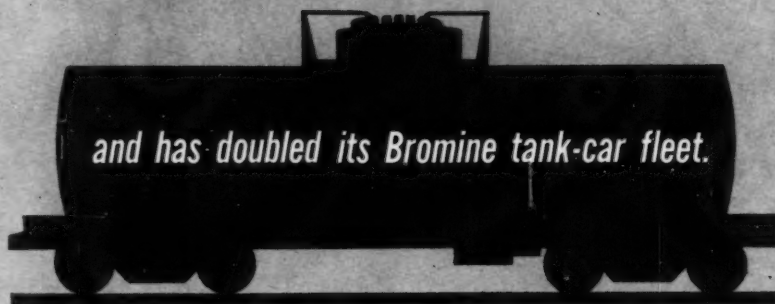
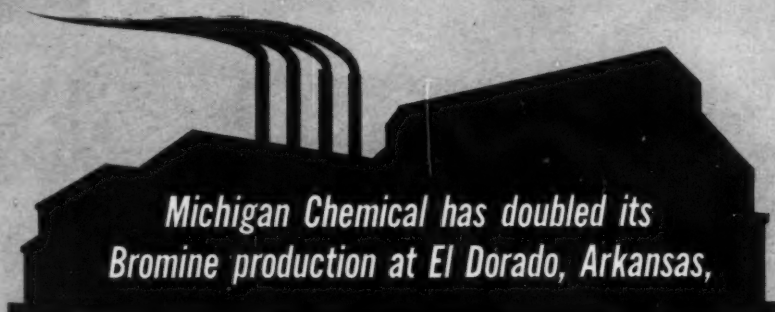
The benefits to users of Wyandotte Chlorine and Wyandotte Caustic in its many forms are plain. We can ship economically and with dispatch . . . by barge or ocean tanker, truck or tank car. May we discuss the possibilities with you? *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Offices in principal cities.*

WYANDOTTE CHEMICALS



MICHIGAN ALKALI DIVISION

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MORE BROMINE FOR YOUR PROCESSES

With the placing on stream in August of new facilities at the Michigan Chemical Corporation — Murphy Corporation bromine plant near El Dorado, Arkansas, there now is available an added supply of bromine for your normal requirements, your immediate peak demands, and your plans for increased bromine usage. And because of our enlarged tank-car facilities you can be sure that your delivery schedule can be met.

This added capacity to our present production at El Dorado and from plants at Saint Louis and Manistee, Michigan

permits active research by you on this basic chemical element to take advantage of bromine's unique properties and characteristics.

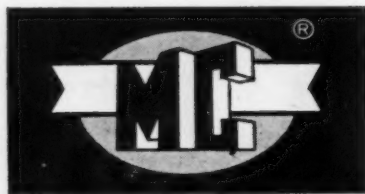
Investigate what bromine offers you in higher yields, processing advantages, and new product opportunities. Also, check with us on the use of Michigan Chemical brominated compounds — standard production or custom-made to your specific needs.

Write for a copy of our authoritative compilations, "BROMINE, Its Properties and Uses," and "How to Handle Bromine."

For complete listing of Michigan Chemical products,
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In production, with CPI assist: compact Buicks, other '61 models.

New Cars Boost Chemicals

With Ford, Studebaker, Chrysler, and American Motors already in production of '61 models and 22 other makers slated to start their runs by the end of this month, aluminum shapes up to be the CPI material making the most significant gain in next year's autos. But the '61 cars also bring innovations in the auto industry's use of a spate of other chemical products.

Biggest boost for aluminum in automotive markets: the introduction

of V-8 powerplants with aluminum engine blocks and heads in GM's three new compacts: the Buick Special, Oldsmobile F-85 and Pontiac Tempest (aluminum engine optional).

Ultimate sales volume of these compacts not only should determine the potential sales value of aluminum engines but also could supply impetus for predicted record-high industry sales.

O.K. with Buyers: The early surge of the '61 Rambler, which is powered

by an overhead valve aluminum six, indicates initial acceptance of the aluminum engine. Rambler has accounted for 7.3% of total industry sales to date (an increase of 23% for a similar period last year) and its maker, American Motors predicts it will capture 10% of the '61 market.

If the new aluminum-engine compacts can spur sales, both the auto industry and its chemical suppliers will be looking for record production despite the effects of a slowed economy, backed-up '60 inventories, and price reductions on foreign makes. Although July and August dealer sales dipped below those of the comparable '59 period, Chevrolet's General Manager Edward N. Cole has predicted that the '61 market will reach 7 million passenger cars. George Romney, American Motors' president, believes 50% of '61 sales will be in compact cars.

Aluminum and plastics are both scoring gains of 10% or more in use per car. Industry sources estimate the '61 car will average 62 lbs. of aluminum and possibly 30 lbs. of plastics. Per-car usage of glass and paints are expected to hold at last year's levels: 39.4 sq.ft. and 6 gal., respectively. Rubber usage will dip to an average of 110 lbs./car; but the anticipated increase in car production could cause the auto industry's '61 rubber consumption to climb to 350,000 long tons.

Aluminum's inroads have not been limited to GM and Rambler. Chrysler products have added aluminum distributor housings, and Plymouth features an aluminum grille. An aluminum transmission converter bell housing and transmission extension will be standard on '61 Lincoln Continentals.

Aluminum rocker arms will be used on full-sized Buicks. All Ford models will have aluminum die castings on the front engine covers. Corvair plans (but may drop) an aluminum case for its new four-speed transmission.

Innovations for Plastics: Significant new uses for plastics have been disclosed. Ford is using eight lightweight polyurethane seals on each car along with rubber to seal in the lubricant in its 30,000-mile factory-sealed grease job.

It's reported that the Buick Special will have a molded plastic instrument

panel. Glove boxes in Thunderbirds and Lincoln-Continentials will be made from molded polyethylene 0.08 in. thick. Ford Econoline trucks will have door handles and window cranks formed from Delrin acetal resin.

Chrysler Corp. has changed to higher-nylon-content fabrics. Continental will have a new nylon coating on all instrument panel wiring, and a Dacron transmission fluid filter. Its dash panel is insulated with a new 2½-lb.-density glass-fiber plastic.

Dodge hard-tops and station wagons have new polyurethane foam headlinings. The kick-panels in all Ford products except Continental are polyethylene. Ford has new antifogging plastic equipment on trim materials.

New Rubber Uses: Rubber is another industry product that figures prominently in the '61 picture. Mercury is using a rubber strip running the length of each side to act as a bumper. Small rubber seals are being used in most Ford products to protect new prelubed grease fittings.

In general, compacts' tires will weigh about 4 lbs. lighter than the standards.

Other important modifications are in paints, lubricants, glass and ceramics. All Oldsmobile cars will be sprayed with a transparent mixture of silicone, natural wax and a weak solvent.

Compacts will have 10% less glass area than standard models. Valiant, for example, has 720 sq.in. less glass than its parent Plymouth. Chevrolet will use tempered glass for its side windows this year, thus eliminating sheets of polyvinyl butyral needed for laminating.

All American Motors models will have exhaust systems coated with 2 lbs. of ceramic material consisting of borosilicates, clay, borax and titanium dioxide.

All these changes do not add up to any overwhelming increase in consumption of chemical materials by the auto industry in the '61 model year. However, with per-car usage of these materials continuing its yearly rise, and with early indications for heavier auto sales this year, the outlook is bright. Sales to the auto industry—always a major factor in chemical business—now are expected to have an important bolstering effect on over-all sales of chemicals and allied products during the next six months.

Holding Course on Capital Spending

(Actual and anticipated expenditures, in billions of dollars, on new plant and equipment. Source: U.S. Dept. of Commerce, Securities and Exchange Commission.)

Industry group	Year	1st qtr.	2nd qtr.	3rd qtr.	4th qtr.	Annual Totals	Change from '59
Chemicals and Allied Products	'60	.33	.40	.40	.48	1.61	Up 30.9%
	'59	.26	.30	.31	.36	1.23	
Pulp, Paper and Allied Products	'60	.16	.18	.19	.21	.75	Up 19.0%
	'59	.12	.15	.17	.19	.63	
Products of Petroleum and Coal	'60	.53	.69	.63	.72	2.57	Up 3.2%
	'59	.52	.62	.63	.73	2.49	
Rubber	'60	.05	.06	.07	.07	.24	Up 26.3%
	'59	.04	.05	.05	.06	.19	
Primary Nonferrous Metals	'60	.07	.08	.09	.10	.34	Up 9.7%
	'59	.07	.09	.07	.09	.31	
Stone, Clay and Glass Products	'60	.14	.17	.15	.18	.64	Up 20.8%
	'59	.11	.14	.13	.15	.53	
All Manufacturing	'60	3.09	3.76	3.60	4.10	14.55	Up 20.5%
	'59	2.46	3.02	3.02	3.57	12.07	

CPI Bucks the Trend

Chemical process industries will be exhibiting an individuality all their own this fall by running against the general business tide on capital spending.

Most CPI companies are either following through with their earlier capital spending programs or increasing those budgets, according to last week's government survey on business's plans for expenditures on new plant and equipment. In general the survey shows an unmistakable trend toward greater caution—peeling back earlier investment plans—in the face of economic uncertainty.

The over-all business community, which only three months ago had been planning to lay out capital funds at the annual rate of \$38 billion this fall, has now trimmed that figure by \$1 billion. Result: a leveling in fourth-quarter capital spending at a \$37-billion annual rate—the same as in this third quarter.

A strong exception to this trend is apparent in the CPI sector, however. For example, chemical companies are increasing their fourth-quarter outlays to an annual rate of \$1.7 billion—fourth-quarter total spending would

be \$100 million above this quarter's outlays. This would bring the industry's '60 expansion and modernization bill to more than \$1.6 billion (table, above).

Meaning of the general trend toward caution, say government economists: the big capital goods boom of '58-'60 may be nearing its end.

More Mid-East Plants

New CPI projects are under way on both sides of the political fence in the Middle East.

Under a new technical-assistance protocol signed last week, the Soviet Union will help with a number of industrial projects in the Syrian sector of the United Arab Republic. Included: aid in building a 25,000-tons/year lubricating oils plant and a nitrogen fertilizer plant with a capacity of 110,000 tons/year of ammonium nitrate. Russia will also aid Syria in prospecting for oil and other minerals.

Meanwhile, private industry expands in Israel. Electrochemical Industries Ltd. (Acre) will double chlorine output to 30 tons/day, and will put up a 10-tons/day polyvinyl chloride plant.

Shopping in the West

Yugoslavia will rely to a "considerable extent" on plants and processes engineered abroad in its drive to meet ambitious new chemical industry targets, according to a new report by a team of British businessmen who toured the country last May on behalf of the Federation of British Industries.

The British hope to snare a good part of these purchases, but the Yugoslavs plan to shop around. "Price and credit facilities—particularly the latter" will be the all-important factors in determining who wins the contracts, the report says.

During the past five years Yugoslavia doubled chemical production, and looks for more gains during the '61-'65 plan. Among its output goals: sulfuric acid, from 130,000 long tons now, to 700,000 tons/year by '65; caustic soda, 50,000 to 75,000 tons; soda ash, 90,000 to 150,000 tons; chlorine, 8,000 to 30,000 tons; synthetic fibers, 20,000 to more than 30,000 tons; plastics, 14,000 to 60,000 tons.

Plans call for building a major petrochemical complex to produce ethylene, propylene and butenes for making polyethylene, styrene and polystyrene, phenol, acetone, detergent alkylate.

Eventually, synthetic rubber will be produced. In the meantime, imports of this product are expected to rise from 13,000 tons in '59 to possibly 60,000 tons/year within five years.

Pinching on Imports

Dwindling foreign exchange reserves are forcing India to cut down its imports of sorely needed nitrogenous fertilizers. Between April '60 and March '61, India will get only about 35% of its fertilizer needs, the government now estimates.

In terms of ammonium sulfate, that means a demand of 2.3 million tons will be met with a supply of only 826,000 tons. Local production, crimped by a shortage of coal at the Sindri plant, will amount to only 516,000 tons. Only 310,000 tons of ammonium sulfate will be imported.

This shortage underlines the urgency behind India's efforts to attract foreign investments in its fertilizer plant building program. So far these efforts have been disappointing.



Kefauver: In new rap at drug industry, a blast on antibiotic prices.

Profits, Prices and Probers

Antibiotics manufacturers are manning their defenses against last week's charges by the Senate antitrust subcommittee that they've been charging the public too much for products that are covered by patents.

Sen. Estes Kefauver (D., Tenn.) — the subcommittee's militant chairman — noted that prices of broad-spectrum antibiotics (the largest single segment of the ethical-drug business) held steady from 1951 to '60. Meanwhile, he said, prices of penicillin and streptomycin — unprotected by patents — were dropping. Antibiotics prices were cut 15% just one month before last week's sessions (*CW*, Aug. 27, p. 39).

Kefauver also criticized what he called an "amazing similarity" in prices charged by rival producers, and asserted that such price patterns are not found in industries with "real competition."

The sessions on antibiotics, however, did not provide so fertile a field for the Kefauver subcommittee as did the earlier investigations on tranquili-

zers, steroid hormones and antidiabetic drugs. There were no more allegations of "7,000% markups," for instance.

American Cyanamid's president, W. G. Malcolm, replied he was proud that his company could hold the price line while labor costs went up 90% and equipment costs 40-50%. Malcolm said Cyanamid's Lederle Division has been meeting its profitability goal — net profits equal to 15% of sales — and that this is considered a necessary margin in a volatile industry in which a leading product can become obsolete overnight.

Kefauver said he thought Lederle's over-all earnings ratio to be too high. And he took Bristol-Myers' Bristol Laboratories Division to task for what he considered its high markup on tetracycline, its major product.

The subcommittee plans to hold one more set of hearings, probing vitamins, sulfa drugs and other products. Then it will start considering proposals for new legislation affecting the drug industry.

Chlorine Rides a Boom

Chlorine makers are moving ahead with expansion plans this week, banking on the steadily growing pulp and paper industry to swallow up the increased output.

One of the "Big Five" merchant producers of chlorine, Allied Chemical's Solvay Process Division has just revealed plans for a major expansion: capacity of its more-than-400-tons/day plant at Brunswick, Ga., will be increased 100 tons. And Olin Mathieson, another of the "Big Five" (the others: Hooker, Diamond Alkali, Columbia-Southern), will build a \$13-million, 180-tons/day chlorine and caustic soda plant at Charleston, Tenn. (*CW Business Newsletter*, Sept. 3).

Chlorine is clearly booming (though this is not the case for its coproduct, caustic soda). Most recent chlorine expansion has been for captive markets. But many, including the above two, are tied to the growing paper industry. Paper production for the first half of '60 is about 3½% ahead of a year ago, indicating that this year's total may hit more than 35 million tons. Last year's 34-million-tons total was spectacular, compared with '58's 30.8 million tons.

Apparently this represents enough of a growing market to encourage those who sell chlorine to papermakers, despite competition from chlorine dioxide. More paper and more paper bleaching are creating—for now at least—room enough for everybody.

As Solvay President W. H. Blumfield points out, the market for chlorine is growing particularly in the Southeast. This is where most recent pulp and paper expansions have shown up (see also p. 116). Latest figures on that area's paper production: 12 million tons/year in '58 to 13.7 million in '59.

Most chlorine, of course, still goes into production of other chemicals. But pulp and paper companies—though they've been increasing their own output of chlorine—are still the biggest single merchant market for this product. Total chlorine end-use hasn't changed in five years: 80% chemicals, 16% paper, 5% other.

The outlook is for continued expansion. One prediction—by Hooker's general development manager, Donald Taylor—is that production will rise from this year's estimated 4.6 million tons to 10 million tons in '70.

COMPANIES

Philips Roxane, subsidiary of Philips Electronics and Pharmaceutical Industries Corp. (New York), has acquired Chemico Laboratories (Miami, Fla.), manufacturer of ethical pharmaceuticals. Previously, Philips had acquired Anchor Serum Co. (St. Joseph, Mo.) and Columbus Pharmacal Co. (Columbus, O.). Philips plans to extend marketing of Chemico's products on a national basis, with initial emphasis on Reticulose, an antiviral drug.

Resisto Chemical (New Castle County, Delaware) has filed with the U.S. Securities & Exchange Commission for a public offering of 200,000 shares of common stock at \$2.50/share. Resisto—headed by William Barrentine—was organized in '58 for development, manufacture and sale of special protective coatings and insulation products.

Dixon Enterprises, subsidiary of Dixon Chemical & Research Corp. (Bloomfield, N.J.), now has clearance for its plan to buy into D. Kaltman & Co. (Jersey City, N.J.), wholesale druggist (*CW*, July 2, p. 24). Kaltman will sell 100,000 shares of common stock to Dixon now; Dixon has an option to buy 500,000 additional shares during the next three years.

Valspar Corp. (Ardmore, Pa.) plans to authorize additional common stock so it can acquire Rockcote Paint Co. (Rockford, Ill.). Rockcote Chairman R. J. Baudhuin became president of Valspar several months ago after he acquired 125,000 of Valspar's 476,000 common shares.

Vick Chemical Co. (New York) will change its name next month, if stockholders ratify a board of directors proposal. The 55-year-old firm will be known as Richardson-Merrell Inc. Management feels that the Vick name is too closely identified with the company's proprietary drugs, whereas ethical and veterinary drugs now account for 43% of total sales, and chemicals and plastics account for 12%. In the fiscal year ended June 30, sales were up 14.8%, to \$132.3 million; earnings, up 18.3%, to \$14.4 million.

EXPANSION

Asbestos: Jefferson Lake Sulphur Co. (New Orleans) is arranging the financing for construction of a plant to process 2,500 tons/day of chrysotile asbestos ore at Copperopolis, Calif. Engineering studies have been carried out by Tellepsen Petro-Chem Constructors (Houston). Completion date: by fall of '61. The deposit is said to contain 15 million tons of proved chrysotile ore. Total output is expected to be marketed in California.

LPG Hydrocarbons: Hudson Engineering Co. (Houston) will build a \$4-million gas processing plant for oil and gas producers in the Port Acres Field of Jefferson County, Texas. It will process up to 150 million cu.ft./day of gas, turn out gasoline, liquefied petroleum gases, other hydrocarbons.

Salt: Newly organized Smith Chemical Products (Honolulu, Hawaii) is building three solar evaporation ponds to produce industrial-grade salt for the Hawaiian market, which now imports 50-75 tons/month. Smith plans to market three by-products: gypsum, magnesium oxide, and bromides.



Ameripol Rubber plays undercover role for Spalding

At the core of each Spalding-made Major League baseball is a "cushioned cork center" covered with a quarter-inch layer of Ameripol Rubber.

More important than the amount of rubber used are the rigid requirements for constant quality. The center must be perfect in every way, with uniform resilience from ball to ball.

Indicative of Spalding's quality control is the fact that balls are wound in a sealed room where temperature and humidity are held uniform at all times. This all helps insure that each ball meets Official Major League specifications.

If high quality is important in *your* rubber products, check with Goodrich-Gulf. From production research and quality control, to technical service and warehousing, we're organized to meet your needs. For information contact Goodrich-Gulf Chemicals, Inc., 1717 East Ninth Street, Cleveland 14, Ohio.



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ACETONE—low-boiling solvent that permits high solids concentration, particularly useful in high-low lacquer systems. Good for paint and varnish removers.

3

MIBK—medium-boiling with excellent solvency characteristics. Has high tolerance for diluents. Gives solutions of low viscosity and high solids concentration.

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DAA—high-boiling solvent that improves blush resistance. Excellent for hot lacquers. Ideal for decorative brushing lacquers because of mild odor.

2

MEK—low-boiling, strong solvency for all resins used in lacquer. Gives low viscosity solutions, high solids concentration, high diluent tolerance.

5

EAK—high-boiling solvent, excellent blush resistance, good diluent tolerance, and high solvency for surface-coating materials. Slow evaporation contributes to good flow-out, prevents pinholing and bubbling.

Now—the standard of comparison for lacquer solvent systems . . .

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There are very good reasons why this is so. For example:

Ketone solvent systems give superior finishes in almost any formulation at lowest cost. Ketones yield solutions of higher solids or permit greater diluent content

with either aromatic or aliphatic solvents. In addition, ketone-based solvent systems assure complete flexibility in formulating. When you buy high-purity solvents from Shell, you add the latent solvent you prefer.

High-purity, active solvents available from Shell include: acetone, MEK, MIBK, DAA, EAK, as well as latent solvents MIBC, IPA, and industrial ethyl alcohols. Shell also provides technical assistance—

backed by years of experience and one of the world's best-equipped surface coatings laboratories.

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Washington Newsletter

CHEMICAL WEEK
September 17, 1960

Nixon would back tighter regulation of drugs and cosmetics if elected, says Secy. of Health, Education & Welfare Arthur Flemming. "Personal conversations" with Nixon, Flemming says, indicate that Nixon would favor: more authority for factory inspection and more enforcement of controls in drug manufacture; certification of all antibiotics; requiring manufacturers to report incidents of adverse reaction to drugs; extension of food and color additives laws to the cosmetics industry.

Flemming included these measures in the "progressive" legislation he said Nixon would support, which also includes stricter federal enforcement of water- and air-pollution control.

•
Nixon advocates a federal subsidy for private basic research as the way to seize the lead in science. He would authorize the National Science Foundation to direct the program.

Under his proposal, small research institutes would be set up around the country by such groups as universities and existing research institutions. They would be administered by semi-autonomous boards set up by the universities, and financed jointly by private industry, universities, foundations and state and federal governments. Scientists would be free to conduct research without administrative or teaching burdens, and the work would be coordinated to prevent duplication.

Senator Kennedy has also called for more federal support of basic research but has not spelled out any proposals.

•
FDA Commissioner George Larrick is backed by Secy. Flemming as outside investigators of the Food & Drug Administration prepare to report on their findings. Flemming said he has "complete confidence" in Larrick, when asked to comment on a *Saturday Review* article calling for the commissioner's resignation because of his alleged knowledge of the activities of Dr. Henry Welch, ousted chief of the Antibiotics Division.

Investigators will make their reports by Oct. 1. They were assigned to (1) find out if any other FDA officials have had questionable outside interests, and (2) review the scientific decisions of Welch to determine whether any of them might have been influenced by his financial interest in drug publications.

•
Legislation extending deadlines on food additives tests is recommended by the Food Additives Committee of the Manufacturing Chemists' Assn. Chairman Kenneth Mulford of Atlas Powder Co. told the American Bar Assn. meeting in Washington that the realities of scientific research and development demand such action.

Research workers and facilities are so bogged down in testing old products that research on new products has been "almost ex-

Washington Newsletter

(Continued)

cluded," according to Mulford. He also cited the need for developing short-term additive tests as a matter of economic necessity, lest incentive for new research be stymied by the costliness of tests.

The food additives law set a deadline of March 5, '60, with provision for one-year extensions by Secy. Flemming. Mulford suggested changing the law to let the Secretary grant whatever extensions are necessary where no undue risk to public health is involved and where investigations are proceeding in good faith.

A new division in the U.S. Public Health Service will consolidate and speed up work in the air-pollution field. Medical research and engineering work has until now been divided between two other divisions of PHS. About \$1 million was diverted from other parts of the budget to finance the new division. Vernon G. Mackenzie, engineer and long-time civil servant, will be division chief.

One of the division's primary jobs will be administration of the two-year study of health effects of auto exhaust ordered by Congress.

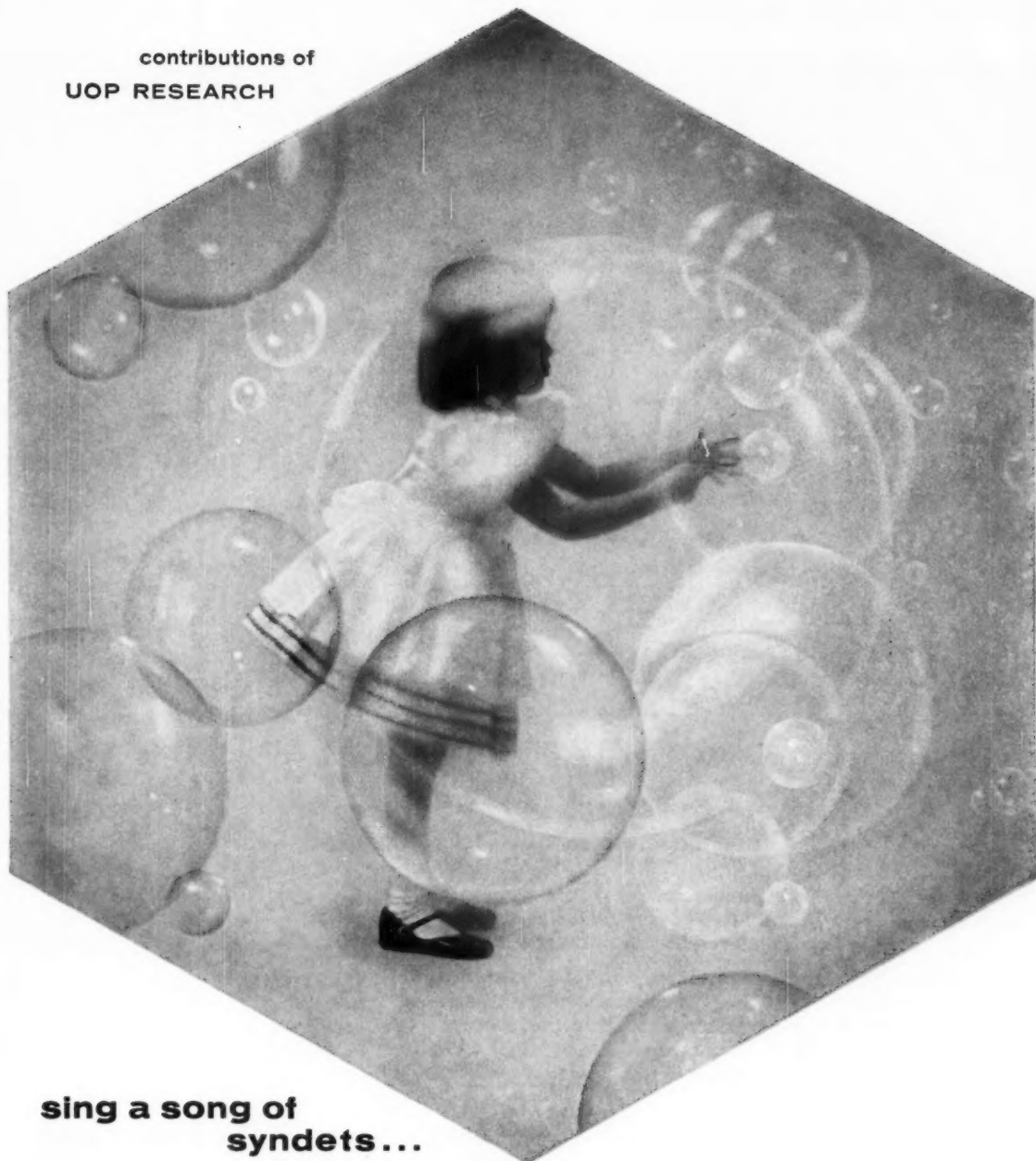
A plan to divert more defense subcontracts to small business will be urged by small-business advocates in Congress next year. It's designed to put some teeth into the requirement that work is supposed to be farmed out to small firms "to the maximum extent feasible" on all contracts of more than \$1 million. There is considerable opposition to the plan from the Pentagon, large defense producers, and the Congressional armed services committees.

The idea, proposed by Sen. William Proxmire (D. Wis.), calls for SBA representatives to be stationed at the plants of major prime contractors—as they now are at major military procurement offices—with access to production schedules and authority to direct subcontracting to qualified small companies. Because it would mean adding more red tape to contracting procedures, opponents cringe at the idea of placing civilian agency SBA into the chain of command between the military and its contractors.

The Treasury Dept.'s new survey on industry depreciation practices is drawing an excellent response, according to Treasury officials. About 6,000 replies to the department's questionnaire are expected, covering firms that account for about two-thirds of corporate depreciation deductions.

It's too early for major conclusions on industry's view of the effect of faster depreciation on investment decisions, but Under Secretary Scribner says responses so far indicate a willingness to make book depreciation conform with tax depreciations as a condition for liberalization. The majority also indicate willingness to forego capital gain treatment as a condition for more liberal depreciation allowances.

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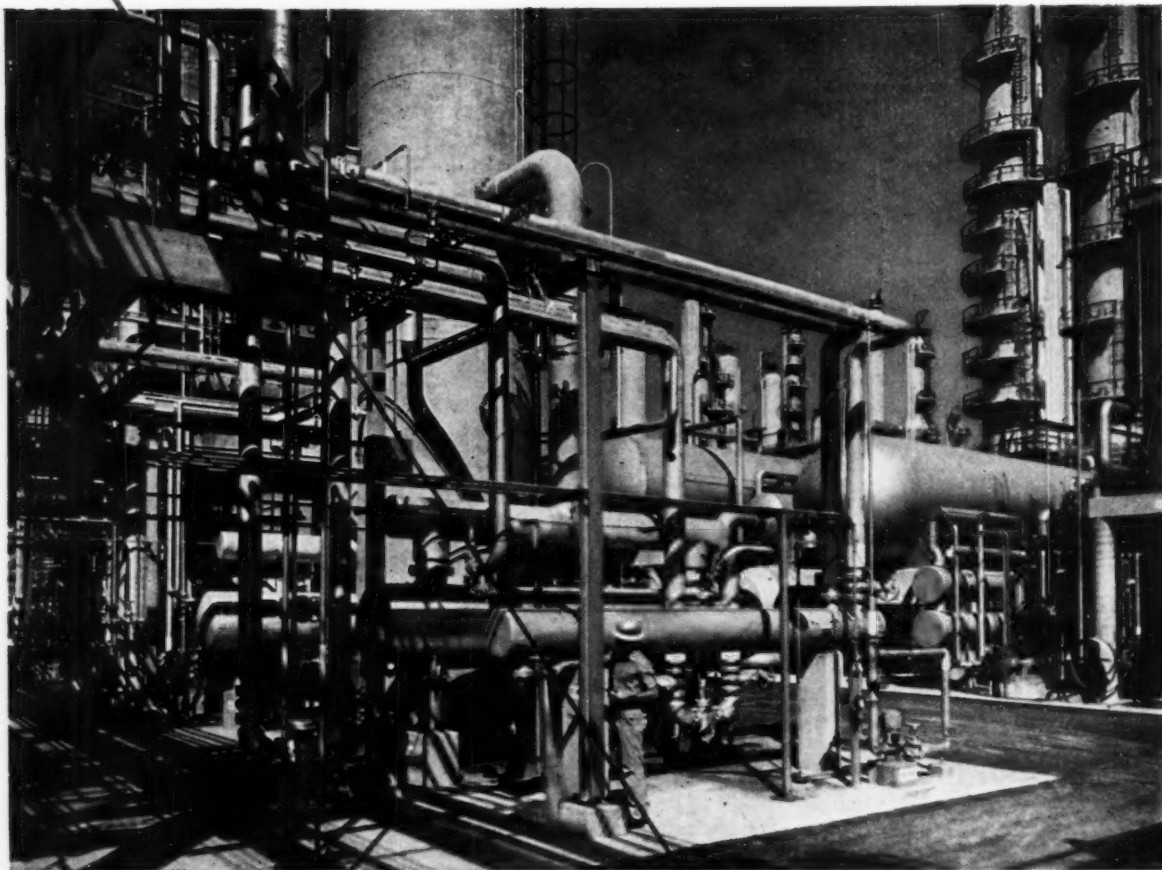
For the precise formulation of these miracle cleansers, credit our creative chemical industry. For the ready availability of petrochemicals so essential to their manufacture, credit goes to our progressive petroleum refiners.

A pioneer petroleum research organization, UOP has long been active in originating and developing new, more efficient ways to make chemicals from petroleum. And UOP processes play a vital role in the production of petrochemical intermediates important in the manufacture of synthetic detergents.



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Probing new packages: Market researchers find new heat-in-the-bag packages rate high with consumers.

Market Research Data Makes the Sale

Last week Du Pont's Film Dept. released the first details of its latest study of markets for films in food packaging—this one on the fast-growing "heat-in-the-bag" concept. The new study emphasizes the vast growth potential of this new kind of food package, points up the lively competition brewing among rival films (polyesters, polypropylene, nylon, polyethylene) as well as paper and aluminum foil. It illustrates also how Du Pont has neatly turned merchandising research into an effective selling tool.

Du Pont's Film Dept. management knew for some time that heat-in-the-bag packaging showed real promise as an outlet for its Mylar polyester film and polyethylene film. Typical bag construction: ½ mil of polyester film with a 2-mil polyethylene coating.

But no one—not even the packers, distributors, wholesalers and retailers who handled these items—

knew just how rapidly the new package was taking hold, why people bought them or what packers and distributors should do to aid the growth of this promising market.

Du Pont's study—a survey of 20,000 households across the U.S.—pinpoints for the first time exactly where the heat-in-the-bag package is headed.

High Promise for Pouches: Du Pont's Film Dept. marketing research section last week cataloged these benchmarks for the new food pouches:

- Some 36% of all households queried have tried heat-in-the-bag foods.
- Of these, over half made repeat purchases.
- Nearly 70% of those queried said they liked the idea, almost twice as many who said they had tried the new package.

The market researchers found that purchases of the new pouch packages correlated very closely with

other frozen food purchases noted on this and other studies.

Consumers reported that the convenience in using these pouch-packaged foods was a major reason for their purchase.

Biggest consumption of the pouches was found to be in the New England and Middle Atlantic regions—areas that got the heaviest doses of promotional effort by packers and distributors.

Spreading the Word: When the study was completed, Film Dept. sales staffers hastened copies of the study to their customers—the converters who make the pouches—and in turn to the converters' customers—the packers, distributors, and retailers of the packaged food products.

The salesmen took with them some suggestions, too, based on the survey results, aimed at helping converters and packers to capitalize on the apparently ready market for their products. Among them:

(1) Packers and distributors should consider using free samples to get more people to try the food packages. Since there is strong interest in pouch packaging and a healthy repeat purchasing pattern, Du Pont marketers reasoned that sampling might boost immediate sales.

(2) Packers should consider beefing up their promotional efforts in smaller communities and in the Far West—areas that have received little promotion of the pouch concept. Correspondingly, sales in these areas have been well behind those in larger Eastern seaboard communities.

Films in Pouches: What the growth of the heat-in-the-bag packages will mean to various films is not yet clear, however. According to Du Pont, three basic pouch constructions are now in use: (1) polyester film/polyethylene; (2) aluminum foil/polyethylene; (3) paper/polyethylene.

A polyethylene/foil/polyester pouch is also used to some extent but is considered a minor factor.

Du Pont says that polyester film now has 80-85% of the total pouch market for food products—about 69 million pouches in '59. On this basis, it's a good bet that Du Pont may be selling something like 200,000 lbs. of polyester film for this application alone. And the industry looks for this market to double each year over the next five years.

Foil constructions currently are used in about 10-15% of all food pouches, according to Du Pont, with paper/polyethylene pouches having the remainder of the market. But other plastics are eyeing these markets, will likely make a bid for them. Among them: polypropylene, nylon, PVC, polyethylene (alone), polystyrene and Du Pont's Teslar polyvinyl fluoride film.

Pouch Outlook: It's clear that Du Pont's study of consumer acceptance of the heat-in-the-bag package represents a strong bid to keep polyester well ahead of its competitors. However, it's a good bet that as the market for these pouches expands—doubling every year over the next five years—more film producers will be watching these developments closely, trying to spot potential applications for their materials.

Researching the Consumer: Besides shedding light on an almost unknown subject, the Du Pont con-

sumer study points up a trend in CPI market research: more companies are finding that it pays to research their customers' markets—not just for their own end-use analyses, but also for use as a potent sales tool as a giveaway item.

Salesmen who have authoritative, up-to-the-minute market information on customers' markets almost always command greater attention than competitors' salesmen who are less well equipped. And when customers use such information to intensify or redirect their efforts, the result is often increased business for raw-material suppliers—particularly for those who have supplied the data. Du Pont's heat-in-the-bag study underscores the benefits of using market research data as a sales tool.

How Studies Have Changed: Merchandising research—data on customers' markets that is given to them without cost—is not new with Du Pont. Early studies by cellophane marketing men were done during the mid-'20s. But since that time the techniques for performing such market research, as well as using the data, have changed in many ways. Among the most important technique: systematic exploitation by salesmen of market studies to influence customer marketing activities, win new business.

Two Kinds of Studies: The Film Dept.'s merchandising research studies have taken many forms over the years—from how to sell more bread and sweetened cookies to boosting sales of Christmas tree ornaments; from methods of operating an efficient produce department to an analysis of how polyethylene is used on the farm (now being compiled); from hints on selling snack foods to markets for magnetic tape and metallic yarns (nonpackaging segments of Film Dept. sales).

According to Fred Clark, manager of marketing research for the Film Dept., most of the department's studies are in one of two broad categories: "once-and-done" studies, such as the pouch-packaging survey, in which one study fills the bill (markets that are relatively unknown); and continuing surveys that are updated periodically to spot shifts in buying habits, consumer opinions.

One example of the latter kind of study is Du Pont's survey of supermarket shopping patterns. It was re-

leased early this year, is the firm's most successful and best known merchandising research project. The '60 version represents the sixth complete study of supermarket shoppers' habits and buying patterns. The series originated during the mid-'30s, has now gained the acceptance as a leading barometer of supermarket customer analysis.

Survey Methods: Clark points out that merchandising research is simply market research applied to customers' markets and given to customers free. "We use all the tools of marketing research in doing these surveys," says Clark.

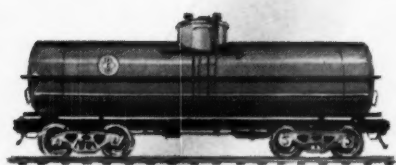
He emphasizes that it's difficult to pin down just what returns a company either expects or receives from a given merchandising research study. Film Dept. management, he says, determines which market areas to study for customer use on the basis of how valuable the information might be in opening new sales opportunities for Du Pont.

This usually means that market growth has been slowed by one of many problems that are rooted in improper or inadequate market research data in customers' hands.

Studies Mean Sales: But the critical step in reaping full benefit from the studies—and one in which Du Pont has become adept—is in applying them to achieve maximum gain in sales volume.

Since sales staffers give copies of these studies to converters and to their customers, the company assures that the surveys are authoritative and accurate. In this way, customers receive valuable market data at no cost. (The company discloses only the cost of the recent supermarket shoppers' study: \$50,000. It's likely that none of the other company-sponsored surveys cost quite this much.)

This, of course, creates considerable interest in behalf of the salesman, helps him gain the kind of attention he needs to operate effectively. More than that, these studies provide good reasons for his making a call. (Unlike some CPI companies, Du Pont insists that its salesmen have a predetermined purpose for each sales call.) Still, Harold Ladd, Du Pont's corporate marketing research chief, emphasizes that the surveys are not cure-alls, but one of many useful sales tools.



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METAL ORGANICS



Abundance of Metal Organics—

Metal organic chemicals have grown into a half-billion-dollar business during several decades of steady progress, and in the next 10 years the industry is expected to triple its earnings.

Because the metal organics field as a whole is extremely diverse and complex—in both markets and technology—this progress report seeks mainly to serve as a guidepost to those U.S. chemical process industries firms that stand to profit as the metal organics industry grows to full stature as a major segment of the nation's chemical industry.

LEAD LEADS THE WAY

Extreme toxicity of organo-lead compounds in general has thwarted broadscale efforts to push lead chemicals into commercial applications.

One notable exception is, of course, tetraethyl lead, which has become the top commercial metal organic (see chart, p. 58). Since its introduction in 1923, TEL demand has grown apace with mounting need for higher-octane ratings in automotive and aviation gasolines; resulting output of the chemical has climbed to an estimated 485 million lbs./year.

Until now the business has been divided between two producers—Du Pont and Ethyl Corp.—but soon to come on the scene will be Houston Chemicals, a Chatham-Reading subsidiary, which will make, among other products both tetraethyl lead and tetramethyl lead (CW, Sept. 3, p. 23).

TEL Future Threatened: Growth of TEL production slowed in recent years (graph, p. 58), partly because of an influx of catalytic reforming capacity (alternative source of octane improvement), to some extent because of the '58 recession, and because other additives in gasolines (phosphates, boron, etc.) has cut down the use of TEL.

The legally allowable limit of TEL concentration in automotive fuels (3 cubic centimeters/gallon of gasoline) appeared at one time to be the prime factor that would curtail use of TEL; but so far this saturation point has not been reached in either regular- or premium-grade gasolines. In fact concentration of TEL in regular-grade fuel has declined during the past few years (see table, p. 58). More significant are

other demand-damping factors. For example, increasing popularity of so-called compact cars—first European-made, now American—is forcing a consumer switch from premium-grade fuels to regular grades more suitable for use in small-car engines; moreover, the greater miles/gallon efficiency of the small cars will somewhat reduce gasoline consumption that otherwise might be greater as more cars move onto the nation's highways.

A harder jolt on TEL markets will come if turbine auto engines go into use by '65 as many expect (CW, June 18, p. 115). These revolutionary power units can tolerate no TEL whatever (because of deposit build-up). Potential impact on TEL markets is hard to predict, however, because of uncertainty about speed with which turbine engines would supplant traditional piston engines. If they move in fast, TEL markets could slump badly.

Another development that is moderating TEL demand is the rapid swing to jet-powered aircraft. This, of course, cuts into consumption of aviation gasoline, hence into TEL demand—an impact intensified because TEL concentration in aviation gasoline is well over the 3 cu. cm./gallon ceiling imposed on its use in automotive fuels.

Consumption of TEL in aviation fuels slumped from more than 93 million lbs. in '58 to probably less than 70 million lbs. in '60; and the decline is expected to continue—perhaps to 52 million lbs./year by '65.

The future of lead organics could be altered by competitive process developments, but for TEL there's little likelihood that process changes will become competitively significant.



Du Pont's process—used by Ethyl Corp. under license—is based on reaction of lead-sodium alloy with ethyl chloride. Chatham-Reading is expected to follow the same road.

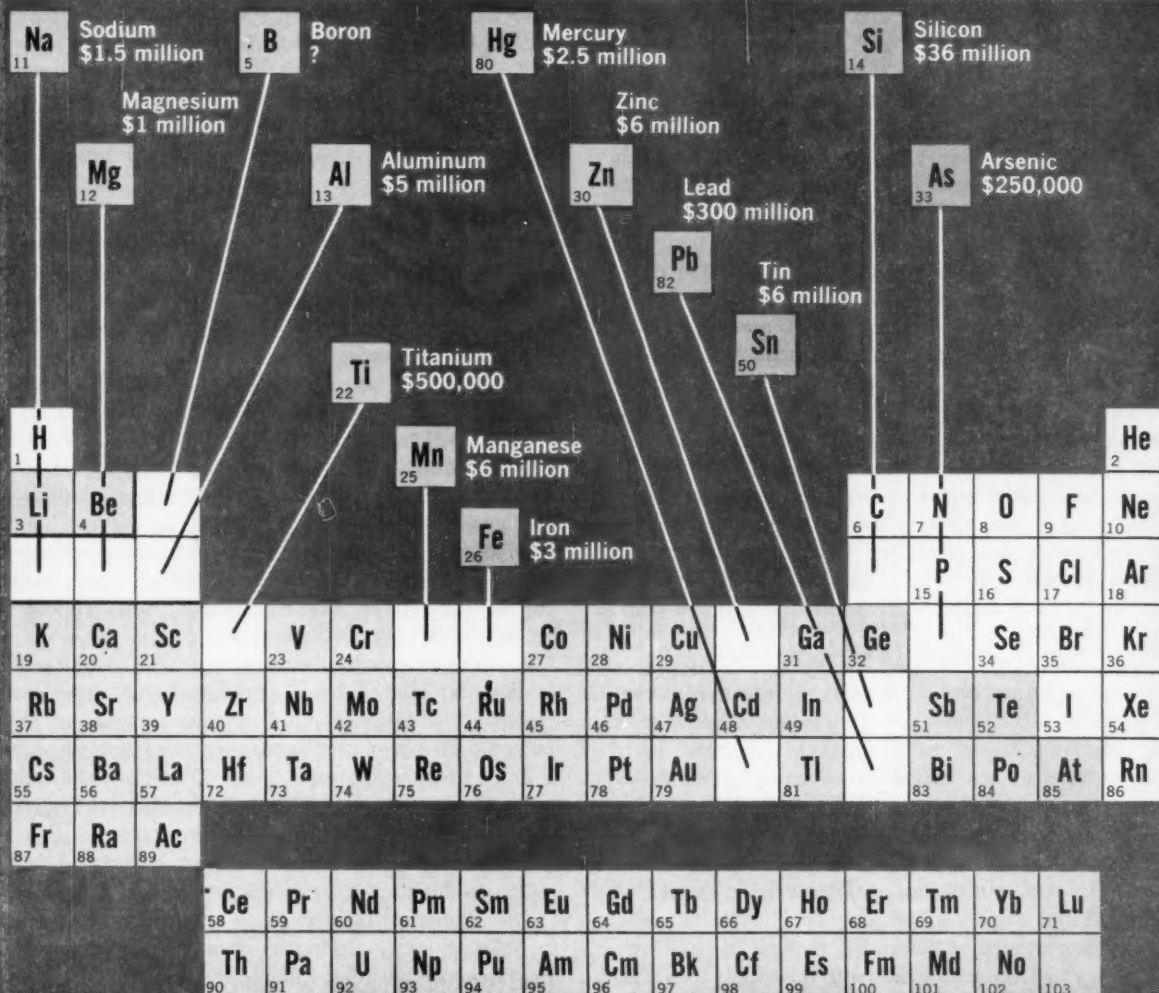
One alternative route—the Ziegler process—eliminates sodium as raw material, is based on reaction of metallic lead with a triethyl aluminum complex (in an electrolytic cell). Triethyl aluminum is regenerated, and the method uses only lead, ethylene and hydrogen as raw materials.

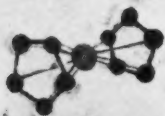
Another method, developed by Ethyl, obviates use

Reaping Big New Market Harvest

Leading Metal-Organic Chemicals — Now a \$370-Million/year Market

 Elements forming commercially important metal-organics
 Other elements that form metal-organic compounds





METAL ORGANICS

of metallic lead, instead employs lead compounds such as oxide or sulfide, which are reacted with sodium, lithium, or aluminum alkyls to yield TEL.

Meanwhile there's considerable activity aimed at developing more uses for lead organics. The Lead Industries Assn., for example, is expanding its application research program (carried on by A.D. Little, Inc.) on organic-lead compounds.

The applications work is currently concentrated on use of compounds such as tetrabutyl and tetraphenyl lead in modification of plastics—with specific emphasis on use in cross-linking additives for polyethylene.

Other compounds—e.g., alkyl lead halides, sulfides and salts—are being screened for biological activity.

Methyl Nudges TEL: Increasing interest in tetramethyl lead—TEL's first cousin—is spurring production activity by Du Pont, Ethyl and, soon, by Chatham-Reading.

Tetramethyl lead—or “methyl” as it's known in the trade—was first put into gasoline last spring by Standard Oil Co. of California (*CW Technology Newsletter*, April 30). Socal's gasolines now contain various mixtures of TML and TEL, depending on the grades made. (Incidentally, only 2.06 ml. of TML is needed to provide the same amount of lead contained in 3 ml. of TEL.)

Comparison tests show that TML is more effective than TEL, especially when used in newer gasolines with high aromatic hydrocarbon content. It's estimated that nationwide use of TML would boost octane ratings of premium-grade gasolines noticeably, and effect savings to additives users of more than \$30 million over other methods now available.

It's still early to pin down accurately the market impact TML will likely have on tetraethyl lead; but some experts predict that all European gasolines will contain TML in two years, that half the gasoline sold in the U.S. will contain TML within the next five years.

VERSATILE SILICON

Silicon forms organic compounds that can conveniently—albeit somewhat arbitrarily—be included in a general listing of metal organics. Silicones—more technically termed siloxanes—comprise the major boom area for silicon organics.

(The silicon atom does not possess a metallic-type lattice structure—it's more akin to the diamond, for example—but nonetheless exhibits metallic as well as nonmetallic properties; because of this “metalloid's” feebly electronegative nature the element has a greater tendency to form compounds with nonmetals than with metals.)

The road to a host of silicon-organic compounds

starts with reaction of elemental silicon with methyl chloride, in presence of copper catalysts, to produce a mixture of methylchlorosilanes; these are then separated into methyltrichlorosilane, dimethyldichlorosilane and trimethylchlorosilane—from which approximately 450 silicone resins, greases, paints and elastomers are made.

Ready acceptance of silicon organics by consuming industries is reflected in steady growth of the silicone resins business during the past half decade (*see graph*, p. 56). In '54 resin sales amounted to 1.7 million lbs., worth \$5.5 million; by '58 sales had almost doubled to 3.2 million lbs., valued at more than \$9.2 million.

Silicone resin production at first outpaced sales, later eased off into better balance with demand.

In '56, for example, production of silicone resins hit a high of almost 3.5 million lbs. while sales were about 2.75 million lbs.; but '58 production was down to 3.1 million lbs., slightly less than the 3.2 million lbs. sold.

Resins, however, comprise but a relatively small part of the total silicones market. Major general category is made up of various silicone fluids, which together represent about 40-45% of the silicones business (*see table p. 56*).

(Incidentally, the U.S. Tariff Commission, in its latest report on synthetic organic chemicals, pulled silicone elastomers out of a catch-all basket for the first time; production of elastomers in '58 amounted to 5.2 million lbs. and sales were more than 4.8 million lbs., worth \$19 million.)

Three U.S. firms—Dow Corning, General Electric, Union Carbide—now make silicone elastomers.

Dow Corning has long led the silicones parade, now has an estimated 65% of the total business; General Electric probably gets about 30%; Union Carbide's Silicones Division, about 5%.

In a few years, however, the silicones production lineup may begin to change significantly. Reason: basic patents run out in '65 and '66, and new producers will probably appear on the scene.

And there's much to encourage such planning—both in the host of established applications and prospects for new uses. For example, silicone experts peg the potential silicone market in maintenance paints at some 5 million lbs./year (worth about \$5 million). Silicone temperature-indicating paints are catching on fast; in the past two years this market has reportedly grown from nothing to a 100,000-gal./year business, is expected to double, perhaps triple in the next few years.

Optimism runs high on likely application of silicone in building uses—notably as an additive in concrete. Researchers report that 1 lb. of 30% solution of sodium monomethylsilicate in 1 cu. yd. of concrete improves strength 40-50%. Some now predict a 220-million-

lbs./year market for silicones in concrete—if weathering tests now under way are successful.

Other areas into which silicones are making inroads include aluminum siding finishes, the appliance industry, cosmetics and furniture polishes.

Silicates—Some Slump, Some Soar: Silicate esters were first made several years ago by Hodges Research and Development (Calif.) and by Anderson Chemical, but Carbide, Anderson and Montrose Chemical are now the only volume producers of silicates.

Most demand is for ethyl silicate. Its market volume climbed to a peak 5.86 million lbs. in sales in '56 (production was 6.83 million lbs.), although it has since been declining. Output has leveled off at about 2 million lbs./year (see graph, p. 57).

Bulk of ethyl silicate consumed is used as binder for molds in precision casting. This use—about 90% military—grew rapidly during late World War II years, and afterward because of demand for precision-molded buckets and blades for jet aircraft engines; but this business declined rapidly because of military de-emphasis of manned aircraft in favor of rockets.

Likelihood of new uses for the relatively low-priced chemical (32¢/lb.) and pickup in commercial molding uses are expected to reverse the trend and send demand for it climbing in the near future. The advent of turbine engine automobiles, for example, would give the compound a big boost.

Other silicates such as hexa (2-ethylbutoxy) disiloxane have important jobs in aircraft hydrolytic systems. Market for this chemical was about 300,000 lbs. in '59, probably will be close to 500,000 lbs. this year.

Other silanes now being pushed include didodecyl diphenylsilane as a new high-temperature fluid (by Metal & Thermit Corp.) and some completely phenylated persilanes with thermal stability in the 800-degree range and good beta-radiation resistance (introduced by Anderson Chemical).

Almost all of the glass-fiber finishes now used are reactive silanes such as vinyl triethoxysilane.

Tetramethylsilane is known to be used in the X-15 high-speed, high-altitude plane project, but exact application of the chemical hasn't been revealed.

ORGANO-TINS: CONTROVERSIAL BUT PROMISING

The organo-tins seem relatively unimportant if their markets are measured in terms of elemental tin consumption, but considered as organic chemicals *per se* they take on greater significance in variety and size of potential applications. Total U.S. production of organo-tins now probably amounts to about 3 million lbs./year.

Of the wide variety of organo-tins that can be

What Is a Metal Organic?

Nomenclature that attempts to define and delineate metal-containing organic compounds is in a chaotic state; businessmen, market analysts, researchers, scholars all make their own rules, invent definitions to serve their special interests.

Some consider as metal organics only those compounds containing elements that are true metals; others include borderline elements (i.e., metalloids such as arsenic, silicon) possessing metallic properties.

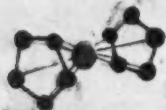
Some restrict the definition to compounds with metal-to-carbon bonds; others include compounds in which metal is linked to carbon through another element — usually sulfur, oxygen, or nitrogen. Opinions differ, too, on whether metal salts of organic acids are "true" metal organics.

To the annoyance of semantic purists, industrial chemists tend to take a liberal view of the terminology — largely because final characteristics of the chemicals are, after all, the chemist's prime concern.

In this report the all-inclusive term "metal-organic" embraces a wide variety of organic compounds, most of which fall into one of four major subgroups (above) labeled according to prevalent industrial terminology.

Four Types of Metal Organics

Example	Structural Characteristics
ORGANO-METALLIC TETRAETHYL LEAD	<p>Metal is bonded directly to carbon atom</p>
METALLO-ORGANIC SODIUM METHYLATE	<p>Metal is linked to carbon by third atom, e.g., oxygen, nitrogen, sulfur</p>
COORDINATION COMPOUND CHLOROPHYLL A	<p>Metal is loosely held to rest of molecule by weak "coordination" bonds</p>
SANDWICH COMPOUND FERROCENE	<p>Metal is bonded uniformly to all carbon atoms</p>



METAL ORGANICS

synthesized, four basic types have won footholds in commercial applications representing greatly divergent types of consuming industries.

For example, the dialkyl tins are used to stabilize plastics and chlorinated rubber, are also used to treat poultry for worms.

Trialkyl and triaryl tins also have pronounced biocidal activity of varying potency, depending on the constitution of the organo constituent in each derivative.

Versatility of the tri-tins is further underscored by many research programs now under way aimed at creating or expanding the use of these chemicals in such applications as slime control in pulp and paper making, preservation of wood and textiles, pesticides, and as paint preservatives (tributyl tin in particular is promoted as a fungistat and antifouling agent in paints).

Still a relatively small market—but with big potential—for organo-tins: as catalysts in one-shot urethane foam production. Dibutyl tin dilaurate and dibutyl tin 2-ethylhexoate stand out, compete with tin salts such as tin oleate and tin octoate. Foam makers are divided, usually pick one type, disdain the other. The dibutyl compounds are more efficient (six times more oleate or octoate needed) and produce finer-textured foams but tend to cause foam degradation at elevated temperatures. Tin compounds are not used for two-step

foaming, for which tertiary amines are standard catalysts.

Pesticide applications could provide highly lucrative markets for organo-tins if some stumbling blocks can be avoided.

Opinions vary widely on likelihood that organo-tins will soon make deep inroads into pesticide markets. Some formulators say they are now losing interest in organo-tins, partly because of tight patent controls, which discourage newcomers from spending money on development projects, and partly because of limited available knowledge about tin toxicology as it pertains to allowable pesticide residues on food crops. Such information is of vital importance in light of the government's stringent allowances, now practically zero.

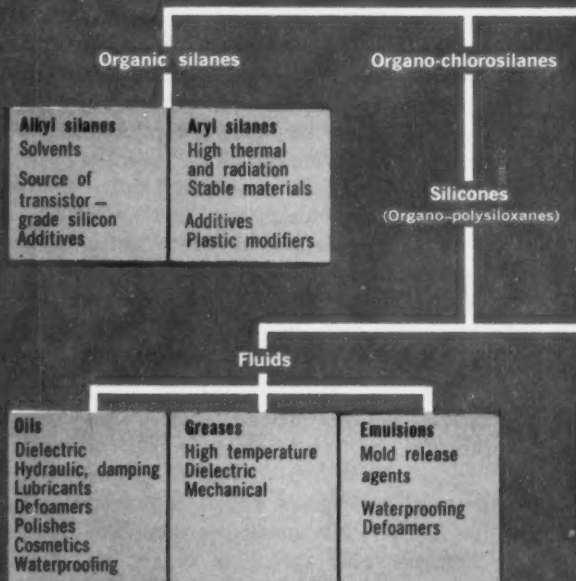
But other experts are highly optimistic about use of organo-tins as pesticides. They admit that certain organo-tin compounds—notably triethyl tin—are extremely toxic to human beings; but this degree of toxicity does not run across the board. Related compounds such as trioctyl tin are far less hazardous, but suffer adverse publicity because they are related to more toxic chemicals.

Moreover, some organo-tin proponents believe they have an ace that might trump the toxicity problem. Toxicity of tin compounds, they point out, persists only so long as the metal remains attached to several carbon

Silicone Market Breakdown

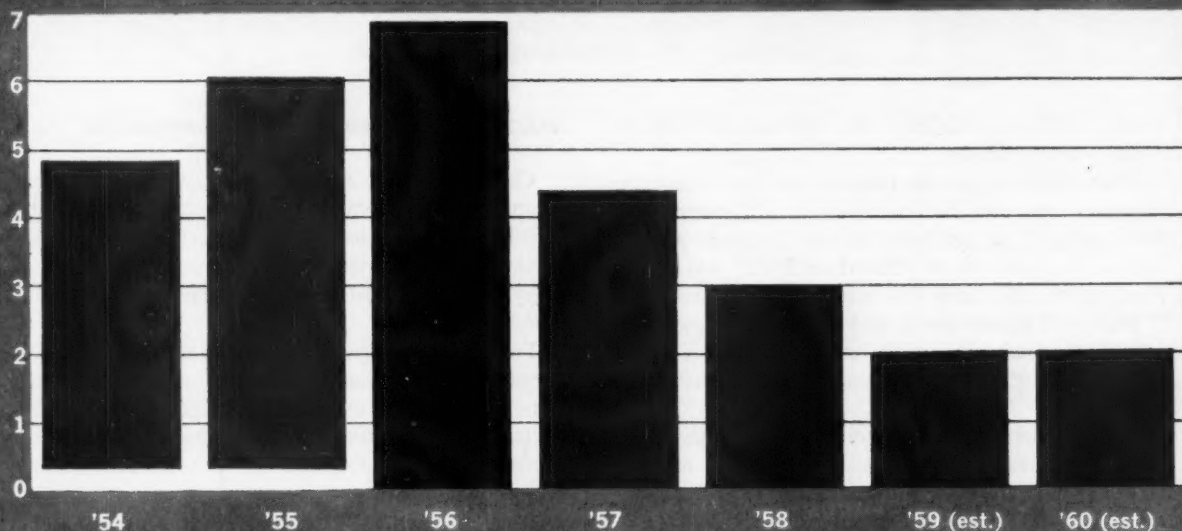
Silicone rubbers	20 %
Fluids	40-45 %
Resins	12 %
Electrical applications	10-12 %
Textile, leather	11-18 %

Silicon-Organics



Ethyl Silicate Output

(Million lbs.)



atoms of an organic molecule. They hope to show that at least some organo-tin pesticides break down into harmless compounds rapidly enough after use to eliminate any hazards to food consumers. Modified molecular structures, too, may reduce toxicity hazards to human beings.

Reactivity Is an Asset: A high degree of chemical reactivity sets organo-tin apart from its silicon and germanium analogs, has opened certain specialized markets for the tin chemicals.

Dibutyl tin maleate, for example, will react readily

with hydrogen chloride; this property helps make the chemical useful as a stabilizer for vinyl chloride polymers. However, organo-tin sulfur compounds reportedly are making inroads into this application of the maleate.

Tetraphenyl tin also acts as a "chlorine getter," is used to prevent electrical conductance by contaminating hydrogen chloride sometimes formed—by electric arcing—in dielectric liquids such as chlorinated diphenyls used in transformers.

There are a host of other uses for organo-tins. Mono- and dibutyl tin salts are used as silicone curing catalysts;

— A Study in Versatility

Silicon

Organic silicates

Water repellants Plastic modifiers
Stone preservatives
Glass-fiber finishes
(Alkyl substituted silicates)

Mold binding
(Ethyl silicate)

Heat transfer agent
(Cresyl silicate)

High-temperature hydraulic fluid
(2-Ethyl butyl silicate)
(2-Ethyl hexyl silicate)

Polysilicates

High-temperature hydraulic fluids
Low-temperature refrigerator compressor lubricants
(2-Ethyl butyl polysilicate) (2-Ethyl hexyl polysilicate)

Elastomeric compounds

Molding
Gaskets
O-rings
Stripping

Extruding
Tubing
Wire and cable
Insulation

Coating
Electrical
products
Sealants
Tape

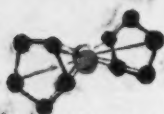
Gum
Polymers

Resins

Molding compounds
Electrical and
mechanical
components

Varnishes
Impregnating
Coating
Bonding
Water repellants

Adhesives
Fabrication
Tape



METAL ORGANICS

others, such as tetraphenyl tin, are used to catalyze olefin polymerizations.

Research on organo-tin polymers and heterometallic polymers containing tin continues in full swing. One such product: a synthetic rubber (polymer of the methacrylic acid ester of tributyl tin oxide) was developed by the U.S. Army Quartermaster Laboratory.

Interest in organo-tins is widespread and expanding; considerable research and development work is going on in Germany, England, France, Japan as well as in the U.S.

In this country Metal & Thermit is the leading producer and researcher of organo-tin chemicals, has put major emphasis, up to now, on butyl tins. The firm has a \$3.5-million metal organics plant at Carrollton, Ky.

Other U.S. producers are Cardinal Chemical (San Francisco) and Advance Solvents (division of Carlisle Chemical Works) at New Brunswick, N.J. A few other companies are also turning out research quantities of organo-tins.

Meaningful capacity data or end-use breakdowns are hard to come by because all producers operate as quietly as possible. In general, however, PVC, applications are pre-eminent, but many other organo-tin uses could develop into major markets.

MAGNESIUM: CLASSICS GO COMMERCIAL

Classic textbook examples of metal organic compounds are the so-called Grignard reagents consisting of alkylmagnesium halides. Now much more than textbook curiosities, Grignards are important intermediates in synthesis of a host of other commercially important compounds.

For example, magnesium organics are used in making tributylphosphine, Sinclair's gasoline additive. Grignards are also essential in the manufacture of pharmaceuticals such as vitamin A, drugs to control high blood pressure, perfumes, insecticides, and for production of many commercial silicones.

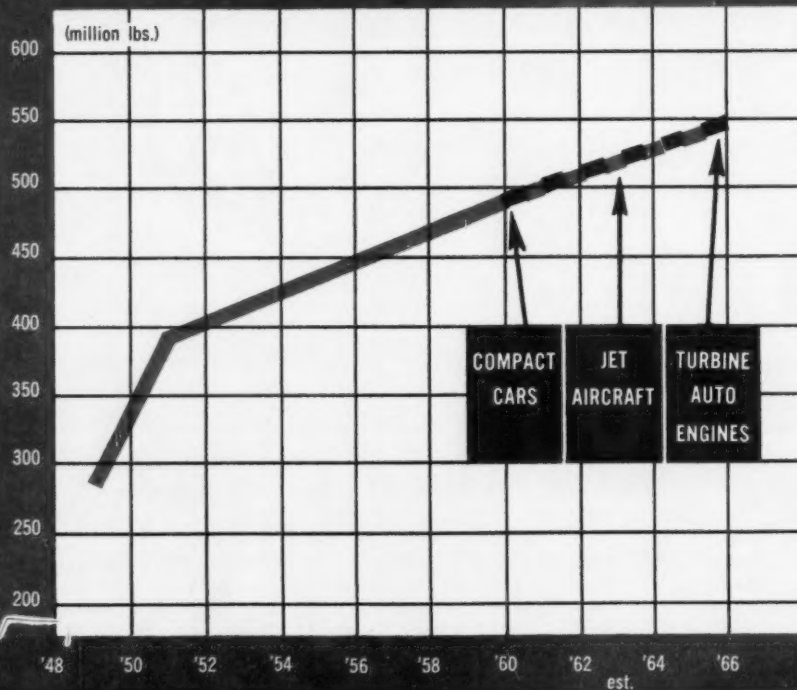
Sales of Grignard compounds—despite substantial consumption—are not impressive; many firms make their own for captive use. However, Arapahoe Chemical Co. (Boulder, Colo.) and Anderson Chemical have developed sizable businesses as producers of Grignards available for sale. One is phenylmagnesium bromide; dissolved in ether, it's sold in 55-gal. lots for about \$1/lb.; another, n-butylmagnesium chloride, in ether, sells for about \$2.50/lb.

Magnesium methoxide is another magnesium organic with good market prospects; it's generally sold as a 5% solution in methanol, finds uses in coating

Tetraethyl Lead: Gasoline Use

	(cubic centimeters/gallon)		
	Regular	Premium	Aviation
1951	1.66	2.02	2.97
1952	1.82	2.16	3.28
1953	2.06	2.39	3.35
1954	2.13	2.50	3.28
1955	2.17	2.51	3.31
1956	2.26	2.54	3.38
1957	2.02	2.51	—
1958	1.96	2.58	—
1959	1.75	2.53	—


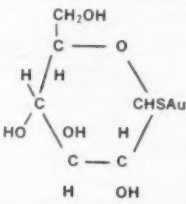
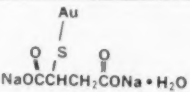
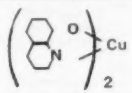
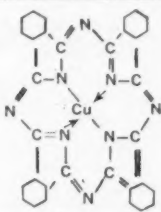
Tetraethyl Lead: Transport Changes Curb Output



Selected list of available metal organic compounds

(Prices listed are approximate)

METAL ORGANICS OF GROUP I

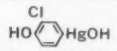

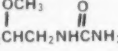
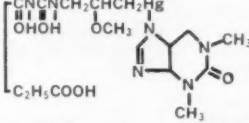

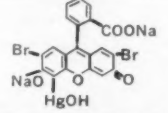
Compound	Leading Producers and Trademarks	Formula	Physical Properties	Process	Price (\$/lb)	Major End-Uses
Butyl lithium	American Potash Anderson Chemical Lithium Corp.	C_4H_9Li	White powder	Reaction of lithium with butyl chloride	\$10 Comm. sol. only	Catalyst for polyolefins alkylating agent for other metal organics and pharmaceuticals
Lithium methoxide	Anderson Chemical	CH_3OLi	White powder	Reaction of lithium with methanol	\$5 Dev. 10% sol.	
Phenyl sodium	Anderson Chemical	C_6H_5Na	Pyrophoric white solid	Reaction of sodium with chlorobenzene	\$17 Dev. 1M sol. naphtha	Phenylating agent
Sodium methylate	Olin Mathieson Harshaw Chemical	CH_3ONa	White solid M. P. = d.	Reaction of sodium with methanol	\$0.39 Comm.	For production of methyl stearate and palmitate. Condensation of alkyl acetoacetic esters
Sodium ethylate	Anderson Chemical	C_2H_5Na	White solid M. P. = d.	Reaction of sodium with ethanol	\$4.50 Dev.	Intermediate in Williamson synthesis
Sodium ethylene bis-dithiocarbamate (NABAM)	Rohm & Haas Du Pont	$CH_2NHCSSNa$ $CH_2NHCSSNa$	Yellow cryst. solid M. P. = d.	Reaction of ethylene diamine with carbon disulfide in caustic soda	\$1.15/gal. Comm. 22% sol. only	Foliage fungicide
Silver picrate	Wyeth, Inc. Piragol	NO_2  NO_2	Yellow crystals		Pharm.	For treatment of urethritis and gonorrheal vaginitis
Aurothioglucose	Schering Solganal		Yellow-green powder		Pharm.	For treatment of rheumatoid arthritis
Gold sodium thiomalate	Merck Myochrysine	Au  $NaOCCCH_2CONa \cdot H_2O$	Yellowish-white powder	Reaction of sodium thiomalate with a gold halide	Pharm.	For treatment of rheumatoid arthritis
Copper 8-hydroxy quinoline	Chemo-Puro Metalsalts		Green amorp. powder	Reaction of 8-hydroxy-quinoline with copper salts	Comm.	Mildew proofing fabrics
Copper phthalocyanine	Du Pont Pittsburgh Coke & Chem. Sherwin-Williams		Blue-green solids	Reaction of o-ClC ₆ H ₄ CN with Cu ₂ (CN) ₂ and copper powder	Comm.	Dye

METAL ORGANICS OF GROUP II

Compound	Leading Producers and Trademarks	Formula	Physical Properties	Process	Price (\$/lb)	Major End-Uses
Magnesium methoxide	Anderson Chemical Pioneer Chemical	$(CH_3O)_2Mg$	Colorless crystalline solid M. P. = d.	Reaction of magnesium and methanol	\$0.40 Comm. 5% sol. methanol	Dielectric coating; cross-linking agent; stable gels
Methyl magnesium bromide	Arapahoe Anderson Chemical	CH_3MgBr	Solutions in ether	Reaction of magnesium and methyl bromide	\$0.77 Comm. 3M. sol.	Alkylating agent in organic synthesis
Methyl magnesium iodide	Arapahoe Anderson Chemical	CH_3MgI	Solutions in ether	Magnesium and methyl iodide	\$3 Comm. 3M. sol.	Alkylating agent in organic synthesis
Ethyl magnesium bromide	Arapahoe Anderson Chemical	C_2H_5MgBr	Solutions in ether	Magnesium and ethyl bromide	\$0.90 Comm. 3M. sol.	Alkylating agent in organic synthesis
Ethyl magnesium chloride	Arapahoe Anderson Chemical	C_2H_5MgCl	Solutions in ether	Magnesium and ethyl chloride	\$0.80 Comm. 3M. sol.	Alkylating agent in organic synthesis
Propyl magnesium bromide	Arapahoe Anderson Chemical	C_3H_7MgBr	Solutions in ether	Magnesium and propyl bromide	\$2.50 Comm. 3M. sol.	Alkylating agent in organic synthesis
Butyl magnesium chloride	Arapahoe Anderson Chemical	C_4H_9MgCl	Solutions in ether	Magnesium and butyl chloride	\$2.50 Comm. 3M. sol.	Alkylating agent in organic synthesis

METAL ORGANICS OF GROUP II—(Continued)

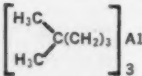

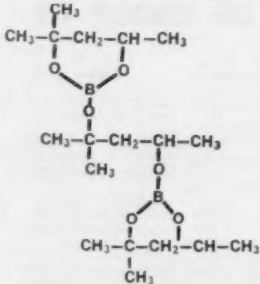
Compound	Leading Producers and Trademarks	Formula	Physical Properties	Process	Price (\$/lb)	Major End-Uses
Phenyl magnesium bromide	Arapahoe Anderson Chemical	C_6H_5MgBr	Solutions in ether	Magnesium and bromobenzene	\$1 Comm. 3M. sol.	Arylating agent in organic synthesis
Parachlorophenyl magnesium bromide	Anderson Chemical	ClC_6H_4MgBr	Solutions in ether	Magnesium and <i>p</i> -chlorobromobenzene	\$1.35 Comm. 2M. sol.	Arylating agent in organic synthesis
Calcium methyllate	Anderson Chemical	$(CH_3O)_2Ca$	White powder M. P. = d.		\$6 Dev.	Catalyst intermediate
Zinc diethyl	Org.-Met Anderson Chemical	$(C_2H_5)_2Zn$	Colorless gas B. P. = 117 C	Reaction of zinc chloride with aluminum triethyl	\$30 Dev.	Polyolefin catalyst; production of ethyl mercuric chloride
Zinc ethylene bis-dithiocarbamate (ZINEB)	Rohm & Haas Du Pont	$\begin{array}{c} CH_2NHCSS \\ \\ CH_2NHCSS \end{array} Zn$	Light-tan powder M. P. = d.	Reaction of di sodium ethylene bis-dithiocarbamate with zinc sulfate	\$0.60 Comm. 65% wettable powder	Foliage fungicide
Zinc naphthenate	Advance Solvents Harshaw Chemical Nuodex Products Ferro Chemical Wilco Chemical	$\begin{array}{c} CH_2CH(CH_2)nCOO \\ \\ H_3C \quad \\ \quad \\ CH_2-CH_2 \end{array} Zn$	Viscous amber liquid	Reaction of a zinc salt with naphthenic acid	Comm.	Paint drier
Diethyl cadmium	Ethyl Corp.	$(C_2H_5)_2Cd$	Colorless pyrophoric liquid B. P. (19mm) = 64 C	Reaction of cadmium acetate with triethyl aluminum	Internal use only	New process; TEL production; synthesis of ketones from acid chlorides
Ethyl mercuric chloride	Metalsalts Du Pont Ceresan	C_2H_5HgCl	Silvery iridescent crystals M. P. = 194 C	Reaction of zinc diethyl and mercuric chloride	\$10 Comm.	Seed fungicide
Ethyl mercuric acetate	Metalsalts	$C_2H_5HgOOCCH_3$	White cryst. powder M. P. = 178 C		\$0.60 Comm. 5% sol. only	Fungicide
Ethyl mercury phosphate	Metalsalts Du Pont New Ceresan	$C_2H_5HgPO_4$	White powder	Reaction of ethyl mercuric acetate with phosphoric acid	\$12 Comm. dust or sol.	Seed fungicide; timber preservative
Ethyl mercury <i>p</i> -toluene sulfenamide	Du Pont Ceresan III	$\begin{array}{c} HgC_2H_5 \\ \\ H_3C \quad \text{benzene ring} \quad -SO_2N- \quad \text{benzene ring} \end{array}$	Crystalline solid		Comm. dust only	Seed fungicide and for bulb rot in gladiolus
Ethyl mercury 2,3-dihydroxypropyl mercaptide	Du Pont Ceresan 75	$\begin{array}{c} OH \quad OH \\ \quad \\ C_2H_5HgSCH_2CHCH_2 \end{array}$			Comm.	Fungicide
Sodium ethyl mercury thiosalicylate	Eli Lilly Merthiolate	$\begin{array}{c} \text{benzene ring} -S-Hg-C_2H_5 \\ \\ C \quad ONa \\ \\ O \end{array}$	Cream-colored cryst. powder	Reaction of ethyl mercuric chloride with thiosalicylic acid in alcohol and NaOH	Pharm.	Bacteriostat; fungistat
Methyl mercuric dicyandiamide	Morton Salt Panogen	$\begin{array}{c} NH \\ // \\ CH_3HgNHC \\ \backslash \\ NHCN \end{array}$		Reaction of methyl mercuric hydroxide and dicyandiamide	Comm. sol. only	Seed fungicide
Methyl mercury oxyquinolinolate	California Spray-Chem. Ortho LM	$\left(\begin{array}{c} \text{quinoline ring} \\ \\ O \end{array} \right) HgCH_3$	Brown solution; pure Comp. not isolated		Comm. sol. only	Seed fungicide
Phenyl mercuric chloride	F. W. Berk Metalsalts	C_6H_5HgCl	White satiny crystals M. P. = 251 C	Reaction of phenyl mercuric acetate and sodium chloride	\$6.75 Pharm.	Antiseptic fungicide
Phenyl mercuric hydroxide	F. W. Berk Metalsalts	C_6H_5HgOH	White powder M. P. = 274 C	Reaction of phenyl mercuric acetate with sodium hydroxide	\$3 Comm.	Intermediate for other organomercuric compounds
Phenyl mercuric acetate	Cleary Guard Chemical F. W. Berk Metalsalts	$C_6H_5HgCOOCH_3$	White lustrous crystals M. P. = 149 C	Reaction of benzene and mercuric acetate	\$5 Comm.	Foliage fungicide, slimicide, antiseptic, mildew-proofing agent, herbicide
Phenyl mercuric borate	F. W. Berk Metalsalts Merfen	$(C_6H_5Hg)_2HBO_3$	White crystalline powder M. P. = d.	Reaction of phenyl mercuric acetate with boric acid	\$8 Comm.	Antiseptic, mildew-proofing agent
Phenyl mercuric naphthenate	F. W. Berk Nuodex Metalsalts	$C_6H_5HgCOOC_8H_{17}$	Colored solution	Reaction of phenyl mercuric acetate with naphthenic acid	\$1.25 Comm. 10% Hg sol. only	Mildew-proofing agent for paint and adhesives
Phenyl mercuric nitrate	F. W. Berk Metalsalts Phenmerzyl	$C_6H_5HgNO_3$	White or grayish-white powder M. P. = 180 C	Reaction of mercuric nitrate and benzene	\$50/kg. Comm.	Antiseptic, germicide, fungicide
Phenyl mercury oxyquinolinolate	Metalsalts	$\left(\begin{array}{c} \text{quinoline ring} \\ \\ O \end{array} \right) HgC_6H_5$	Not isolated	Reaction of phenyl mercuric acetate with 8-hydroxyquinoline	\$6 Comm. 10% sol. only	Fungicide

Compound	Leading Producers and Trademarks	Formula	Physical Properties	Process	Price (\$/lb)	Major End-Uses
Phenyl mercury propionate	Metalsalts Metasol 57	$C_6H_5HgOOCCH_2CH_3$	White powder M. P. = 85 C		\$4.90 Comm.	Mildew-proofing agent for paint
Phenyl mercury oleate	Metalsalts Nuodex Advance Solvents	$C_6H_5HgOOC(CH_2)_7CH=CH-C_6H_{17}$	White cryst. powder M. P. = 45 C	Reaction of phenyl mercuric acetate with oleic acid	\$4 Comm.	Mildew-proofing agent for paint
Diphenyl mercury ammonium propionate	Metalsalts Metasol P or L		Solid M. P. = 180 C		\$6.50 Comm. solid or 10% sol.	Slimecide for paper mills
2-Hydroxy phenyl-mercuri chloride	Metalsalts		Tannish-white powder M. P. = 152 C	Heating phenol with mercuric acetate and treating with sodium chloride	\$17 Pharm.	Antiseptic
Hydroxymercuri chlorophenol	Du Pont Semesan			Heating o-chlorophenol with mercuric oxide	Comm. dust	Turf fungicide
Phenylmercuri triethanol ammonium lactate	Guard Chemical	$C_6H_5HgN(C_2H_4OH)_3$ 	White crystalline solid	Reaction of phenyl mercuric acetate with triethanolamine and lactic acid	\$17.30 Comm.	Foliage fungicide
Phenylmercuri-mono ethanol ammonium acetate	Guard Chemical	$C_6H_5HgNH_2(C_2H_4OH)$ 	White crystalline solid	Reaction of phenyl mercuric acetate with monoethanolamine	\$17.50 Comm.	Foliage fungicide
Diphenyl mercury ammonium oxyquinoline	Metalsalts Metasol DPO		Brown solution not isolated		\$0.80 Comm. 10% sol.	Fungicide
Hydroxymercuri nitrophenol	Du Pont Semesan Bel				Comm.	Feed fungicide
1-[3-(chloromercuri)-2-methoxypropyl] urea	Lakeside Labs. Neohydrin	$ClHgCH_2CH_2CH_2NHCNH_2$ 	White powder M. P. = 150 C		Pharm.	Diuretic agent
9-[(3-hydroxymercuri-2-methoxypropyl) carbamyl] phenoxy sodium acetate	Massengill Mersalyl		Deliquescent crystals	Reaction of mercuric acetate and methanol with salicyl allyl amide-acetic acid and neutralize with NaOH	Pharm.	Diuretic agent
Methoxyhydroxymercuri propylsuccinyl urea	Lakeside Labs. Mercuryhydrin		Bitter crystals M. P. = 198.5 C		Pharm.	Diuretic agent
4-Nitro-3-hydroxymercuri-o-cresol anhydride	Abbott Labs. Metaphen				Pharm.	Antiseptic
2,7-disodiumdibromo-4-hydroxymercurifluorescein	Hynson, Westcott & Dunning Merbromin Mercurochrome		Iridescent green crystals	Reaction of dibromofluorescein with mercuric acetate and NaOH	Pharm.	Topical antiseptic
[di(phenyl mercury) dodecyl succinate]	Nuodex	$CH_3(CH_2)_{10}CH=CH(CH_2COO)(HgC_6H_5)_2$	Liquid B. P. = d.		\$1.25 Comm. 10% sol. only	Mildew-proofing agent for paint

METAL ORGANICS OF GROUP III

Compound	Leading Producers and Trademarks	Formula	Physical Properties	Process	Price (\$/lb)	Major End-Uses
Trimethyl aluminum	Ethyl Corp.	$(CH_3)_3Al$	Colorless pyrophoric liquid B. P. = 126.1 C	Sodium reduction of dimethyl aluminum chloride	\$18 Dev.	Pyrophoric fuel
Triethyl aluminum	Texas Alkyls Ethyl Corp. TEAL	$(C_2H_5)_3Al$	Colorless pyrophoric liquid B. P. = 194 C	Reaction of ethylene and hydrogen on aluminum	\$2 Comm.	Polyolefin catalyst production of alphaolefins and long-chain alcohols; pyrophoric fuel
Tri-n-propyl aluminum	Texas Alkyls	$(C_3H_7)_3Al$	Colorless pyrophoric liquid B. P. (18mm) = 135 C	Exchange reaction propylene and isobutyl aluminum	\$30 Dev.	Polyolefin catalyst
Tri-n-butyl aluminum	Texas Alkyls	$(C_4H_9)_3Al$	Colorless pyrophoric liquid	Exchange reaction butene-1 and isobutyl aluminum	\$30 Dev.	Production of organo-tin compounds
Triisobutyl aluminum	Texas Alkyls Ethyl Corp. TIBAL	$(i-C_4H_9)_3Al$	Colorless pyrophoric liquid B. P. (0.1mm) = 34 C	Reaction of isobutylene and hydrogen on aluminum	\$2 Comm.	Polyolefin catalyst

METAL ORGANICS OF GROUP III—(Continued)

Compound	Leading Producers and Trademarks	Formula	Physical Properties	Process	Price (\$/lb)	Major End-Uses
Tri-n-hexyl aluminum	Texas Alkyls	$(C_6H_{13})_3Al$	Colorless liquid B. P. (0.001mm) = 105 C	Exchange reaction hexene and isobutyl aluminum	\$50 Dev.	Polyolefin catalyst
Tri-2-methyl pentyl aluminum	Texas Alkyls		Colorless liquid	Exchange reaction 2-methyl pentene and isobutyl aluminum	\$65 Dev.	Polyolefin catalyst
Tri-n-octyl aluminum	Texas Alkyls	$(C_8H_{17})_3Al$	Colorless liquid	Exchange reaction octene and isobutyl aluminum	\$50 Dev.	Polyolefin catalyst
Tri-n-decyl aluminum	Texas Alkyls	$(C_{10}H_{21})_3Al$	Colorless liquid	Exchange reaction decene and isobutyl aluminum	\$0 Dev.	Polyolefin catalyst
Aluminum isoprenyl	Texas Alkyls	not yet determined	Straw-color viscous liquid		\$5 Comm.	Polyolefin catalyst
Ethyl aluminum sesquichloride	Texas Alkyls Ethyl Corp. Koppers	$(C_2H_5)_2Al_2Cl$	Colorless pyrophoric liquid B.P. = 204 C	Reaction of ethyl chloride and aluminum	\$2 Comm. \$2 Comm.	Polyolefin catalyst; intermediate
Diethyl aluminum chloride	Texas Alkyls Ethyl Corp. DEAC	$(C_2H_5)_2AlCl$	Colorless pyrophoric liquid B.P. = 208 C	Reaction of TEAL with ethyl aluminum sesquichloride	\$2 Comm.	Polyolefin catalyst; intermediate in production of other organometallics
Ethyl aluminum dichloride	Texas Alkyls Ethyl Corp.	$C_2H_5AlCl_2$	Colorless pyrophoric liquid	Reaction of aluminum chloride with ethyl aluminum sesquichloride	2 Comm.	Polyolefin catalyst
Diethyl aluminum hydride	Ethyl Corp.	$(C_2H_5)_2AlH$	Colorless pyrophoric liquid B.P. = 227.4 C	Reaction of ethylene and hydrogen on aluminum	Dev.	Catalyst reducing agent
Diisobutyl aluminum chloride	Texas Alkyls	$(i-C_4H_9)_2AlCl$	Colorless liquid	Reaction of isobutylene and hydrogen on aluminum	\$2 Comm.	Polyolefin catalyst
Diisobutyl aluminum hydride	Texas Alkyls Ethyl Corp.	$(i-C_4H_9)_2AlH$	Colorless pyrophoric liquid B.P. (0.2mm) = 105C	Reaction of isobutylene and hydrogen with	\$2 Comm.	Reducing agent in manufacture of pharmaceuticals
Aluminum isopropoxide	Anderson Chemical Chattam Chemical Harshaw Chemical	$(i-C_3H_7O)_2Al$	White solid M.P. = 118.5 C	Reaction of isopropanol on aluminum	\$0.32 Comm.	Cross-linking agent; pharmaceutical intermediate; antiperspirant
Aluminum aspirin	Anderson Chemical Abbott Labs.		White amorphous powder M.P. = d.	Reaction of aluminum hydroxide with acetylsalicylic acid	\$2.10 Pharm.	Analgesic, antipyretic, antirheumatic
Aluminum stearate	Aceto Chemical American Cyanamide Harshaw Chemical Mallinckrodt Witco Chemical	$Al(C_{17}H_{35}O_2)_3$	White powder	Reaction of aluminum salts with stearic acid	\$0.40 Comm.	Paint drier, greases, water-proofing agent, cement additive
Triethyl borane	Anderson Chemical Callery Chemical	$(C_2H_5)_3B$	Pyrophoric liquid B.P. 94-97 C	Triethyl aluminum and boron halide or diborane and ethylene	\$20 Dev.	Pyrophoric fuel
Butyl boric acid	Callery Chemical	$C_4H_9B(OH)_2$		Reaction of butyl magnesium bromide with boron esters	Dev.	
Phenyl boric acid	Anderson Chemical	$C_6H_5B(OH)_2$	White solid M.P. 214-216 C	Reaction of phenyl magnesium bromide with boron esters	Dev.	Fungicide, polymer former with silicones, intermediate
Trimethyl borate	Anderson Chemical Callery Chemical American Potash	$(CH_3O)_3B$	Colorless liquid B.P. 68-69 C	Reaction of methanol with boric oxide	\$0.60 Comm.	Brazing flux, intermediate for production of high-energy fuels
Triisopropyl borate	Anderson Chemical American Potash	$(i-C_3H_7O)_3B$	Colorless liquid B.P. 138-140 C	Isopropyl alcohol with boric oxide	\$1.50 Comm.	
Tri-n-butyl borate	Anderson Chemical	$(C_4H_9O)_3B$	Colorless liquid B.P. 115 C (15mm)	Butyl alcohol with boric acid	\$0.90 Comm.	Antigelling agent wax suppressor catalyst
Trihexylene glycol diborate	Anderson Chemical American Potash U.S. Coast Borax		Colorless liquid	Hexylene glycol with boric oxide	\$0.30 comm.	Gasoline additive
Trimethoxyboroxine	Anderson Chemical Callery Chemical	$(CH_3OBO)_3$	Colorless viscous liquid M.P. 130 C (d.)	Reaction of methyl borate with boric oxide	\$0.75 Comm.	Metal-fire-extinguishing fluid

METAL ORGANICS OF GROUP IV

Compound	Leading Producers and Trademarks	Formula	Physical Properties	Process	Price (\$/lb)	Major End-Uses
Tetramethylsilane	Anderson Chemical	$(\text{CH}_3)_4\text{Si}$	Colorless liquid B.P. = 26.5 C	Grignard reaction silicon tetrachloride with methyl magnesium chloride	\$15 Dev.	Solvent and low-temperature applications
Methyltrichlorosilane	Dow Corning General Electric Union Carbide	CH_3SiCl_3	Colorless liquid B.P. = 65.7 C	Reaction of methyl chloride on silicon with copper catalyst	\$0.77 Comm.	Intermediate in production of silicones
Dimethyldichlorosilane	Dow Corning General Electric Union Carbide	$(\text{CH}_3)_2\text{SiCl}_2$	Colorless liquid B.P. = 70 C	Reaction of methyl chloride on silicon with copper catalyst	\$1.24 Comm.	Intermediate in production of silicones
Trimethylchlorosilane	Dow Corning General Electric Union Carbide	$(\text{CH}_3)_3\text{SiCl}$	Colorless liquid B.P. = 57.3 C	Reaction of methyl chloride on silicon with copper catalyst	\$1.25 Comm.	Intermediate in production of silicones
Methyldichlorosilane	Dow Corning Union Carbide	$\text{CH}_3\text{SiHCl}_2$	Colorless liquid B.P. = 41 C	Reaction of methyl chloride on silicon with copper catalyst	\$1 Comm.	Intermediate in production of silicones
Chloromethyl dimethylchlorosilane	Dow Corning Peninsular Chem. Research	$\text{CH}_2\text{Cl}(\text{CH}_3)_2\text{SiCl}$	Colorless liquid B.P. = 115 C	Chlorination of trimethylchlorosilane	\$7.50 Dev.	Intermediate for modifying silicone polymers
Dimethyldimethoxysilane	Anderson Chemical	$(\text{CH}_3)_2\text{Si}(\text{OCH}_3)_2$	Colorless liquid B.P. = 82 C	Reaction of dimethyldichlorosilane with methanol	\$4.50 Dev.	Manufacture of silicone specialties
Dimethyldiethoxysilane	Union Carbide	$(\text{CH}_3)_2\text{Si}(\text{OC}_2\text{H}_5)_2$	Colorless liquid B.P. = 111 C	Reaction of dimethyldichlorosilane with ethanol	\$3.30 Res.	Cosmetics, water repellants, intermediate
Methylphenyldichlorosilane	Dow Corning Metal & Thermit	$\text{CH}_3(\text{C}_6\text{H}_5)_2\text{SiCl}_2$	Colorless liquid B.P. = 205 C	Reaction of silicon tetrachloride with phenyl and methyl magnesium chloride	\$2.50 Comm.	Intermediate in production of silicone oils
Sodium methyl silicate	General Electric	$(\text{CH}_3)_2\text{SiONa}$		Reaction of hexamethyldisiloxane with sodium hydroxide	\$0.48 Comm.	Masonry water repellent
Hexamethyldisiloxane	Dow Corning	$(\text{CH}_3)_2\text{SiOSi}(\text{CH}_3)_3$	Colorless liquid B.P. = 99.5 C	Reaction of trimethylchlorosilane with water	\$4.30 Comm.	For blending to low-viscosity silicone oils
Ethyltriethoxysilane	Union Carbide Anderson Chemical	$\text{C}_2\text{H}_5\text{Si}(\text{OC}_2\text{H}_5)_3$	Colorless liquid B.P. = 159 C	Reaction of ethyltrichlorosilane with ethanol	\$1.50 Comm.	Silicone intermediate
Ethyltrichlorosilane	Dow Corning Union Carbide	$\text{C}_2\text{H}_5\text{SiCl}_3$	Colorless liquid B.P. = 99.3 C	Reaction of ethylene with trichlorosilane	\$0.90 Comm.	Intermediate in silicone production
Ethyl silicate	Anderson Chemical Union Carbide Montrose Chemical	$(\text{C}_2\text{H}_5\text{O})_2\text{Si}$	Colorless liquid B.P. = 166.5 C	Reaction of silicon tetrachloride with ethanol	\$0.325 Comm.	Adhesion promoter; refractory binder; coating in white light bulbs
Bis-Trichlorosilyl ethane	Union Carbide	$\text{Cl}_3\text{SiC}_2\text{H}_4\text{SiCl}_3$	Colorless liquid B.P. = 203 C	Reaction of trichlorosilane with acetylene	\$0.70 Comm.	
Propyltrichlorosilane	Dow Corning	$\text{C}_3\text{H}_7\text{SiCl}_3$	Colorless liquid B.P. = 123.5 C	Addition of propene to trichlorosilane	\$2.12 Comm.	Silicone polymer modification
Amyltrichlorosilane	Union Carbide	$\text{C}_5\text{H}_{11}\text{SiCl}_3$	Colorless liquid B.P. = 170 C	Addition of pentene-1 to trichlorosilane	\$0.90 Comm.	Silicone intermediate
Amyltriethoxysilane	Union Carbide	$\text{C}_5\text{H}_{11}\text{Si}(\text{OC}_2\text{H}_5)_3$	Colorless liquid B.P. = 198 C	Reaction of amyl trichlorosilane with ethanol	\$1.50 Comm.	Silicone intermediate
Dodecyl trichlorosilane	Dow Corning	$\text{C}_{12}\text{H}_{25}\text{SiCl}_3$	Colorless oily liquid B.P. = 288 C	Reaction of dodecyl magnesium chloride with silicon tetrachloride	\$3.95 Dev.	Intermediate
Octadecyl trichlorosilane	Dow Corning	$\text{C}_{18}\text{H}_{37}\text{SiCl}_3$	Oily liquid B.P. (10mm) = 223 C		\$2.60 Comm.	Glass-fiber treatment, silicone modification
Vinyltrichlorosilane	Union Carbide Dow Corning	$\text{CH}_2=\text{CHSiCl}_3$	Colorless liquid B.P. = 90.5 C	Reaction of silicon with vinyl chloride (Sn or Ni catalyst)	\$1.85 Comm.	Treatment of glass fibers
Vinyltriethoxysilane	Union Carbide	$\text{CH}_2=\text{CHSi}(\text{OC}_2\text{H}_5)_3$	Colorless liquid B.P. = 158 C	Reaction of vinyl trichlorosilane with ethanol	\$2.80 Comm.	Glass-fiber treatment
Vinylmethyldichlorosilane	Dow Corning Union Carbide	$\text{CH}_2(\text{CH}_3=\text{CH})\text{SiCl}_2$	Colorless liquid B.P. = 92 C	Methylation of vinyl trichlorosilane	\$3 Comm.	Modification of silicone rubber polymers
2-Ethylbutyl silicate	Anderson Chemical Union Carbide	$\left(\begin{array}{c} \text{C}_2\text{H}_5 \\ \\ \text{CH}_3\text{CHCH}_2\text{CH}_2\text{O} \end{array} \right)_4 \text{Si}$	Colorless liquid B.P. (1mm) = 164 C	Reaction of silicon tetrachloride with 2-ethylbutanol	\$2.50 Comm.	Hydraulic fluid, heat transfer liquid
Hexa-2-ethylbutoxy-diehexane	Anderson Chemical Union Carbide	$\left[\begin{array}{c} \text{C}_2\text{H}_5 \\ \\ (\text{CH}_3\text{CHCH}_2\text{CH}_2\text{O})_3 \end{array} \right]_2 \text{Si}$	Colorless oil B.P. (0.2) = 195 C	Reaction of silicon tetrachloride, 2-ethylbutanol and water	\$2.50 Comm.	Aircraft hydraulic fluid
Beta-carbethoxyethyltriethoxysilane	Union Carbide	$\text{C}_2\text{H}_5\text{OOC}(\text{CH}_2)_2\text{Si}(\text{OC}_2\text{H}_5)_3$	Colorless liquid B.P. = 246 C		\$15 Res.	Intermediate
Beta-carbethoxypropylmethoxydiethoxysilane	Union Carbide	$\text{C}_2\text{H}_5\text{OOC}(\text{C}_3\text{H}_7)\text{CH}_2\text{Si}(\text{OC}_2\text{H}_5)_3$	Colorless liquid B.P. = 228 C		\$15 Res.	Intermediate
Allyltrichlorosilane	Dow Corning	$\text{CH}_2=\text{CHCH}_2\text{SiCl}_3$	Colorless liquid B.P. = 117.5 C	Reaction of allyl chloride with silicon (Cu catalyst)	\$10 Dev.	Glass-fiber finishes

METAL ORGANICS OF GROUP IV—(Continued)

Compound	Leading Producers and Trademarks	Formula	Physical Properties	Process	Price (\$/lb)	Major End-Uses
Phenyltrichlorosilane	Dow Corning General Electric Union Carbide	$C_6H_5SiCl_3$	Colorless liquid B.P. = 201.5 C	Reaction of benzene with trichlorosilane	\$1.46 Comm.	Intermediate for silicone oils, resin elastomers
Diphenyldichlorosilane	Dow Corning General Electric Union Carbide	$(C_6H_5)_2SiCl_2$	Colorless oily liquid B.P. = 305.2 C	Reaction of phenyl magnesium chloride with silicon tetrachloride	\$2.85 Comm.	Intermediate for silicone oils, resin elastomers
Triphenylchlorosilane	Anderson Chemical	$(C_6H_5)_3SiCl$	Crystalline solid M.P. = 96 C	Reaction of silicon tetrachloride with three moles phenyl sodium	\$17.50 Dev.	Intermediate in production of other phenyl silanes and silanols
Diphenylmethylchlorosilane	Dow Corning	$(C_6H_5)_2CH_2SiCl$	Colorless liquid B.P. = 295 C	Grignard reaction diphenyldichlorosilane with methyl magnesium chloride	\$10 Dev.	Intermediate end stopper for silicone oils
Dichlorophenyltrichlorosilane	Dow Corning	$C_6H_4Cl_2SiCl_3$	Colorless liquid B.P. = 260 C	Chlorination of phenyltrichlorosilane	\$10 Dev.	Silicone modification of organic polymer systems
Tetraphenylsilane	Anderson Chemical	$(C_6H_5)_4Si$	Crystalline solid M.P. = 237 C	Reaction of silicon tetrachloride with phenyl sodium	\$25 Dev.	
Hexaphenyldisilane	Anderson Chemical	$[(C_6H_5)_3Si]_2$	White powder M.P. = 352C	Sodium condensation of triphenylchlorosilane	\$24 Dev.	High-temperature applications
Phenyltriethoxysilane	Union Carbide Anderson Chemical	$C_6H_5Si(OC_2H_5)_3$	Colorless liquid B.P.(15mm) = 120 C	Reaction of phenyltrichlorosilane with ethanol	\$3 Dev.	Silicone intermediate
Diphenyldiethoxysilane	Union Carbide Anderson Chemical	$(C_6H_5)_2Si(OC_2H_5)_2$	Colorless liquid B.P.(12mm) = 164C	Reaction of diphenyldichlorosilane with ethanol	\$10.25 Dev.	
Triphenylfluorosilane	Anderson Chemical	$(C_6H_5)_3SiF$	White solid M.P. = 63 C		\$53 Res.	Silicone modifier
Diphenyl di-n-dodecylsilane	Metal & Thermit	$(C_6H_5)_2Si(C_{12}H_{25})_2$	Colorless oil	Reaction of didodecyldichlorosilane with phenyl lithium	\$13.50 Dev.	High-temperature lubricant
4,4'-bis(Triphenylsilyl) biphenyl	Anderson Chemical	$[(C_6H_5)_3Si]_2$ 	White crystalline solid M.P. 286.5 C	Lithium condensation of triphenylchlorosilane and dibromobiphenyl	\$80 Res.	Dielectric compound
Phenylvinylidichlorosilane	Anderson Chemical	$(C_6H_5)(CH=CH)SiCl_2$	Colorless liquid B.P.(1.5mm) = 85.5 C	Reaction of vinyltrichlorosilane with phenyl magnesium chloride	\$15 Dev.	Modifying silicone rubber
Triphenylsilanol	Anderson Chemical	$(C_6H_5)_3SiOH$	White solid M.P. = 155 C	Reaction of triphenylchlorosilane with ammonium hydroxide	\$10 Dev.	
Diphenylsilanediol	Anderson Chemical	$(C_6H_5)_2Si(OH)_2$	White solid M.P. = 140-160 C	Hydrolysis of diphenyldichlorosilane with cold water	\$12.25 Dev.	
Cresyl silicate	Anderson Chemical	$(CH_3C_6H_4O)_2Si$	Colorless liquid	Reaction of cresol and silicon tetrachloride	\$1.10 Comm.	Heat transfer fluid
bis-Trichlorosilylbenzene	Union Carbide	$Cl_3SiC_6H_4SiCl_3$	Colorless liquid B.P.(30mm) = 168 C		\$0.70 Comm.	
Tetraethyl tin	Metal & Thermit	$(C_2H_5)_4Sn$	Colorless oily liquid B.P.(10mm) = 145 C	Reaction of tin tetrachloride with butyl magnesium chloride	Comm.	Fuel additive HCl scavenger
Dibutyl tin dichloride	Metal & Thermit	$(C_4H_9)_2SnCl_2$	Crystalline solid M.P. = 43 C	Reaction of butyl magnesium chloride with tin tetrachloride	\$3 Comm.	Organo-tin intermediate
Tributyl tin chloride	Metal & Thermit	$(C_4H_9)_3SnCl$		Reaction of tetraethyl tin with dibutyl tin dichloride	\$5.25 Dev.	Rodenticide
Dibutyl tin oxide	Metal & Thermit Union Carbide	$[(C_4H_9)_2SnO]_x$	White powder M.P. = d.	Hydrolysis of dibutyl tin dichloride with caustic	\$3.50 Comm.	Condensation catalyst; intermediate for other organo-tins
Dibutyl tin sulfide	Metal & Thermit	$[(C_4H_9)_2SnS]_3$	Colorless oily liquid	Reaction of dibutyl tin oxide with hydrogen sulfide	Dev.	Vinyl stabilizer, antioxidant, lubricity additive
bis(Tributyl tin) oxide	Metal & Thermit	$[(C_4H_9)_3Sn]_2O$	Colorless oily liquid	Hydrolysis of tributyl tin chloride	Comm.	Fungicide and bactericide
Dibutyl tin diacetate	Metal & Thermit	$(C_4H_9)_2Sn(C_2H_3O_2)_2$	Clear yellowish liquid B.P. = d.	Reaction of acetic acid with dibutyl tin oxide	\$3.25 Comm.	Stabilizer for chlorinated organics; catalyst for condensation reactions
Tributyl tin acetate	Metal & Thermit	$(C_4H_9)_3SnOOCCH_3$	White crystalline solid	Reaction of sodium acetate with tributyl tin chloride	\$5.50 Dev.	Fungicide and bactericide
Dibutyl tin dilaurate	Metal & Thermit Union Carbide Ferro Chemical	$(C_4H_9)_2Sn(C_{12}H_{25}O_2)_2$	Colorless crystals M.P. = 27 C	Reaction of lauric acid with dibutyl tin oxide	Comm.	Stabilizer for polyvinylchloride resins; anthelmintic; condensation catalyst
Dibutyl tin maleate	Metal & Thermit	$[(C_4H_9)_2SnO-C(=O)-CH=CH-C(=O)]_x$	White powder M.P. = 110 C	Reaction of maleic acid with dibutyl tin oxide	Comm.	Condensation catalyst
Dibutyl tin di-2-ethylhexanoate	Metal & Thermit	$(C_4H_9)_2Sn(OOCC_6H_{13})_2$	Waxy white solid	Reaction of dibutyl tin oxide with 2-ethylhexoic acid	\$2 Comm.	Catalyst for silicone curing

Rohm & Haas Company

PLASTICIZERS and MODIFIERS

for vinyl and related polymers

Rohm & Haas' broad line of plasticizers for vinyls ranges from monomeric esters (MONOPLEX series) to complex high molecular weight polymers (PARAPLEX series). In addition, Rohm & Haas offers three ACRYLOID resins (acrylic polymers) which are designed to improve the performance properties of rigid and semi-rigid vinyls—particularly processing characteristics and impact strength.

If you process vinyls, here's what you should know about these plasticizers and modifiers.

PLASTICIZER PERFORMANCE PROPERTIES IN EQUAL HARDNESS FORMULATIONS

PLASTICIZER GRADE	% Plasticizer to give 10 sec. Shore A Hardness of 77	PERCENT EXTRACTION LOSS BY:				Low Temperature Flexibility, ³ T _{100,000} , °C.
		Activated Carbon Volatility, ¹ 24 Hrs., 90°C.	Oil Extraction, ¹ 10 Days, 25°C.	Hexane Extraction, ¹ 2 Hrs., 25°C.	1% Soap Extraction, ¹ 24 Hrs., 90°C.	
PARAPLEX G-25	40.5	0.6	+0.2	0.9	0.3	-11.5
PARAPLEX G-40	45	0.7	0.2	0.3	12.0	-13
PARAPLEX G-41	41.5	0.5	0	0.3	3.2	-11.5
PARAPLEX G-50	39.5	1.1	3.0	3.6	8.4	-15
PARAPLEX G-53	40	0.8	1.5	1.7	3.3	-12
PARAPLEX G-54	39	0.7	2.1	2.5	3.6	-13
PARAPLEX G-60	37	0.8	4.8	12.1	1.0	-18
PARAPLEX G-61	37	0.7	4.4	11.5	0.5	-17.5
PARAPLEX G-62	36.5	0.6	3.9	10.8	0.2	-16.5
MONOPLEX S-38	35.5	2.0	2.7	11.5	17.8	-11.5
MONOPLEX S-70	34	8.4	20.5	23.3	8.4	-48.5
MONOPLEX S-73	34	2.5	18.0	22.6	9.4	-41.5
MONOPLEX S-90E	40	0.9	2.7	27.7	0.6	-14.5
MONOPLEX DCP (Dicapryl Phthalate)	36	7.6	16.1	24.6	8.2	-25.5
MONOPLEX DOS (Diocetyl Sebacate)	35	4.1	15.9	28.0	1.0	-56
Diocetyl Phthalate ⁴	35	7.6	7.7	21.8	7.8	-25

¹Based on 10 mil thick film specimens.

²Clash-Berg method using 70 mil molded slab.

³Not offered—included for comparison only.

PARAPLEX polymeric plasticizers

PARAPLEX G-25

- exceptional permanence
- excellent compatibility
- high resistance to ultra-violet light

Paraplex G-25 is a high molecular weight plasticizer which imparts exceptional permanence. Properly stabilized vinyl compounds which contain Paraplex G-25 plasticizer are outstanding in durability. Paraplex G-25 has excellent resistance to extraction by gasoline, oil, water, soap and detergents, as well as freedom from migration in contact with lacquer, alkyd and varnish finishes. Compatibility with vinyl resins is excellent. Original physical properties are retained even after prolonged service at elevated temperatures.

Typical uses include: high grade upholstery sheeting and coated fabric, refrigerator gaskets, surgical tapes, insulation resistant to high temperature, coaxial cable, window channeling, electrical tapes.

PARAPLEX G-40

- high resistance to migration into rubber
- high resistance to extraction by oil

Paraplex G-40 is a high molecular weight polyester plasticizer which combines permanence of plasticizing action with moderate cost. Compounds in which Paraplex G-40 is used show low losses due to volatility, resistance to extraction by aliphatic and aromatic hydrocarbons, and high resistance to migration into rubber and rubber-based materials.

Typical uses include: industrial hose and tubing, industrial and domestic flooring, shoe liners and counters, electrical tapes and industrial aprons.

PARAPLEX G-41

In resistance to extraction by hydrocarbons and to migration into rubber, Paraplex G-41 is on an equal footing with Paraplex G-40. However, Paraplex G-41 is superior in compatibility at high plasticizer levels and after long exposure to humid conditions, in plasticizing efficiency, ease of processing, low-temperature properties, and resistance to extraction by soapy water.

PARAPLEX G-50

- good processing characteristics
- very good over-all permanence

Paraplex G-50 is a general-purpose polymeric plasticizer similar to monomeric plasticizers in its handling and processing characteristics. It is notably superior to dioctyl phthalate in resistance to extraction by oils and hydrocarbons, freedom from volatility, and resistance to migration into lacquers, rubber, and typical baked finishes. Vinyl compounds containing Paraplex G-50 are very stable, as evidenced by the retention of original properties after prolonged aging at high temperatures.

Typical uses include: insulation resistant to high temperature, upholstery sheeting, coated fabric, flooring, refrigerator gaskets, window channeling, surgical tapes, electrical tapes, shoe liners and counters, pigment dispersion vehicles, doll compounds.

MONOPLEX monomeric plasticizers

MONOPLEX DOS

(dioctyl sebacate)

- outstanding performance at low temperatures
- low volatility
- resistance to extraction by soap and detergent solutions

Monoplex DOS is an ester-type plasticizer widely used as a standard in vinyl compounds requiring flexibility at low temperature. It also provides low volatility, high plasticizing efficiency and excellent resistance to extraction by water, soaps and detergents. Like other plasticizers which impart low temperature flexibility, Monoplex DOS is susceptible to extraction by hydrocarbons and deficient on migration resistance. It is a very effective plasticizer for organosol and plastisol compounds.

Typical uses include: primary electrical compounds, sheeting and film for use at low temperatures, jacket compounds, strip-coating compounds.

MONOPLEX S-38

- excellent compatibility
- good permanence at low cost

Monoplex S-38 is a low-cost primary vinyl plasticizer particularly noted for its good permanence properties. It is high in molecular weight and offers definite advantages over dioctyl phthalate. Monoplex S-38 is lower in volatility and better in resistance to extraction by oil and gasoline. Compounds exhibit excellent freedom from tack and exudation. Monoplex S-38 also proves helpful in improving the compatibility of secondary plasticizers.

Typical uses include: low-cost sheeting, flooring, automotive harness tapes, low-cost gasketing, electrical jacketing stocks.

MONOPLEX S-70

- stabilization against effects of heat and light
- good performance at low temperatures

Monoplex S-70 is designed specifically to impart flexibility at low temperature. It is a very efficient plasticizer with good processing properties and a marked stabilizing effect. It has lower volatility than conventional plasticizers for low temperature applications. The stability imparted by Monoplex S-70 not only permits fast, high-temperature compounding, but also affords savings in stabilizer costs. Organosols and plastisols prepared with Monoplex S-70 are of low viscosity and have excellent viscosity stability.

Typical uses include: garden hose, film and sheeting for use at low temperatures, slush-molding compounds, electrical jacket stocks, automotive insulation.

PARAPLEX G-54

- very good compatibility at high humidity and elevated temperatures
- high resistance to extraction by soapy water and oil
- excellent resistance to marring of polystyrene and baked enamels

Paraplex G-54 was especially designed to provide freedom from exudation on exposure to high humidity at elevated temperatures. Other noteworthy properties which this plasticizer imparts include resistance to marring of polystyrene, lacquers, and baked enamels; good resilience; outstanding plasticizer efficiency; good electrical properties; resistance to copper corrosion; and resistance to extraction by soapy water, oils, and gasoline. The properties of Paraplex G-54 make it particularly well suited for many applications which require resistance to both aqueous and organic solvents.

Typical uses include: high-temperature electrical insulation, refrigerator gaskets, electrical and surgical tapes, babywear film, hospital sheeting, and upholstery (household and automotive).

PARAPLEX G-60

- excellent resistance to extraction by soap and detergent solutions
- stabilization against heat
- accepted by F. D. A. for food packaging

Paraplex G-60 is a light-colored, high molecular weight, ester-type plasticizer which provides effective heat and light stabilization in vinyl chloride polymers, nitrocellulose lacquers, and chlorinated rubber compounds. It imparts good flexibility at low temperature, excellent soap and detergent resistance, and low volatility loss. Paraplex G-60 lowers stabilization costs of vinyl compounds and permits high temperature processing.

Typical uses include: general-purpose film, babywear, food packaging and tubing, upholstery sheeting, coated fabric, glove-dipping compounds, flooring.

PARAPLEX G-61

This plasticizer is generally similar in properties and uses to Paraplex G-60. It is superior in retention of compatibility on long term exposure, has better stability against light, and is more resistant to extraction by oil.

PARAPLEX G-62

- excellent stabilization against effects of heat and light
- good general permanence properties
- good resistance to soap and detergent solutions
- accepted by F. D. A. for food packaging

Paraplex G-62 is a high molecular weight plasticizer which combines good permanence properties with excellent stabilization against heat and light. It has low volatility, good resistance to extraction by soap and detergent solutions, and high compatibility over a wide range of concentrations and conditions. Permits fast calendaring and low stabilization costs, provides uniform color and excellent resistance to embrittlement and discoloration.

Typical uses include: general-purpose film, upholstery sheeting, coated fabric, refrigerator gasket stocks, garden hose, doll compounds, food packaging and tubing, wetting, primary insulation, jacket stocks, flooring, insulation resistant to high temperature, window channeling.

MONOPLEX S-73

- excellent low-temperature flexibility
- stabilization against effects of heat and light
- unusually good permanence at moderate cost

Monoplex S-73 couples excellent low-temperature flexibility with good compatibility and low volatility, and thus offers outstanding performance over a broad temperature range. Its stabilizing effects against degradation by heat and light further extend its fields of use. Relatively low price and low specific gravity result in production economy. This low-viscosity plasticizer is particularly useful in plastisol applications where it imparts exceptional viscosity-stability.

Typical uses include: rear windows for convertible automobiles, transparent automobile seat covers, garden hose, storm-window glazing, slush-molding compounds.

MONOPLEX S-90E

- electrical-grade plasticizer
- excellent high-temperature performance
- retention of resistivity after prolonged water exposure

Because it imparts good retention of physical and electrical properties after heat aging and exposure to water, Monoplex S-90E is an excellent plasticizer for electrical insulation. In addition, this plasticizer provides unusual permanence, resistance to microorganism attack, and freedom from copper corrosion. Its low viscosity and ease of incorporation also make it useful in non-electrical applications. In dispersion compounding, it gives low-viscosity plastisols with very good viscosity-stability.

Typical uses include: high-temperature electrical insulation, dispersion compounding, tapes, gaskets, and coatings for awnings and truck tarpaulins.

MONOPLEX DCP

(dicapryl phthalate)

- general-purpose plasticizer

Monoplex DCP is a general-purpose monomeric plasticizer having performance characteristics, in vinyl resins, virtually identical to those of dioctyl phthalate. While it shows less resistance to extraction by oil and gasoline and lower plasticizing efficiency, Monoplex DCP withstands degradation by heat, light and outdoor exposure slightly better than dioctyl phthalate. In plastisol and organosol compounding, Monoplex DCP provides low viscosity, both initially and upon aging.

Typical uses include: general-purpose replacement for dioctyl phthalate.

ACRYLIC MODIFIERS FOR POLYVINYL CHLORIDE

Low cost, ready availability, chemical inertness, high abrasion resistance, and good electrical properties make rigid polyvinyl chloride a very useful material for fabricating a wide variety of extruded, calendared, and vacuum-formed plastic products. However, the unmodified resin has two rather serious shortcomings which restrict its usefulness—poor processing characteristics and low impact strength. These limitations are particularly true for the high-molecular-weight resins which are lower in cost, have better heat and light stability, better chemical resistance, and higher heat-distortion temperatures than their lower molecular weight and copolymer counterparts.

Rohm & Haas offers two acrylic resins, Acryloid K-120 and Acryloid KM-227, which eliminate some of the objectionable features of rigid PVC. In particular, these modifiers make possible the use of the low-cost, high-molecular-weight polymers of polyvinyl chloride in applications which were heretofore not practical. A third modifier, Acryloid KM-220, is very useful in semi-rigid compounds.

ACRYLOID K-120

imparts to rigid vinyls:

- improved processing characteristics
- better heat and light durability
- higher heat-deformation temperature

Processing improvements with Acryloid K-120 begin right on the mill, where a smooth bank and faster mixing are perceptible. Further benefits are: (a) *Calendering*—faster machine speeds, better roll release, freedom from roll plating, and improved gloss, (b) *Extrusion*—better surface qualities, freedom from plating, and increased heat stability, (c) *Vacuum forming*—improved flow of the hot sheet as it is drawn into the mold. In most operations, lower processing temperatures are permitted. Also, time required to rework scrap is cut to a minimum.

ACRYLOID KM-227

gives rigid vinyls:

- very high impact strength
- improved processing characteristics
- retention of impact strength even after considerable overmilling and reworking

Acryloid KM-227 improves substantially the impact strength of rigid vinyl homopolymers and copolymers. An appreciable improvement is noticed even at low Acryloid KM-227 concentrations. Acryloid KM-227 modified stocks show remarkable retention of impact properties after prolonged heat exposure; this means a reduced amount of rejects and safe reworking of scrap. Retention of impact strength after exposure to ultraviolet light is also exceptional. Acryloid KM-227 is also an excellent modifier for PVC compounds containing low levels of plasticizer. Here, its most valuable contributions are improved processing characteristics and better low-temperature impact strength.

ACRYLOID KM-220

in semi-rigid formulations, confers:

- good low-temperature flexibility, without softness at room temperature
- better processing characteristics
- good heat stability

When compounds with low plasticizer levels are modified with Acryloid KM-220, they show improved low-temperature flexibility and low-temperature impact strength, and yet, they do not manifest undue softness at room temperature. Acryloid KM-220 also provides substantial improvement in milling, processing, and handling properties. In rigid vinyls, Acryloid KM-220 may be used to increase impact strength.

Typical uses for Acryloid K-120 and Acryloid KM-227 include: vinyl pipe, window frames and tracks, sliding door channels, moldings, rain gutters and spouts, automotive trim, packaging, signs and displays, chemical-resistant sheeting, contour maps, refrigerator linings, luggage, safety helmets, light diffusers, ductwork, and machine parts; trim for cameras, air conditioners, refrigerators, radios, and electrical appliances; wall paneling and covering for homes, trains, buses, and airplanes.

Typical uses for Acryloid KM-220 include: automobile crash-pad covers, films for packaging, injection-molded electrical fittings such as plugs for electrical cords.



Chemicals for Industry






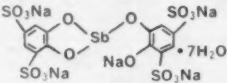
**ROHM & HAAS
COMPANY**

THE RESINOUS PRODUCTS DIVISION
Washington Square, Philadelphia 5, Pa.

METAL ORGANICS OF GROUP IV—(Continued)

Compound	Leading Producers and Trademarks	Formula	Physical Properties	Process	Price (\$/lb)	Major End-Uses
Tetraphenyl tin	Metal & Thermit	$(C_6H_5)_4Sn$	White powder M.P. = 225 C	Reaction of tin tetrachloride with phenylmagnesium bromide	Comm.	Stabilizer in chlorinated transformer oils; Mothproofing agent
Triphenyl tin chloride	Metal & Thermit	$(C_6H_5)_3SnCl$	White crystalline solid M.P. = 106 C	Reaction of tin tetrachloride with phenylmagnesium bromide	\$5.25 Dev.	Biocidal intermediate
Triphenyl tin acetate	Metal & Thermit	$(C_6H_5)_3SnOC(=O)CH_3$	White crystalline solid	Reaction of sodium acetate with triphenyl tin chloride	\$5.50 Dev.	Agricultural biocide
Tetramethyl lead	Ethyl Corp.	$(CH_3)_4Pb$	Colorless liquid B.P.(10mm) = 110 C	Lead-sodium alloy and methyl chloride	\$0.61 Comm.	Gasoline antiknock agent
Tetraethyl lead	Ethyl Corp. Du Pont	$(C_2H_5)_4Pb$	B.P.(10mm) = 78 C	Lead-sodium alloy and ethyl chloride	Comm.	Gasoline antiknock agent
Lead oleate		$[CH_3(CH_2)_7CH=CH(CH_2)_7COO]Pb$	White powder	Reaction of oleic acid with lead hydrate or carbamate	Comm.	In varnishes and extreme pressure lubricants

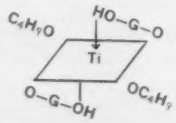
METAL ORGANICS OF GROUP V

Compound	Leading Producers and Trademarks	Formula	Physical Properties	Process	Price (\$/lb)	Major End-Uses
Dimethyl arsine acid (cacodylic acid)	Ansul Chemical	$CH_3As(=O)(OH)_2$	White cryst. solid M.P. = 200 C	Action of water on dimethyltrihalo arsine	\$1 Comm. 80% Powder	Herbicide for pasture and sod renovator
Sodium dimethyl arsenate	Ansul Chemical Vineland Chemical	$CH_3As(ONa)_2 \cdot 6H_2O$	White cryst. solid M.P. = >355 C	Reaction of methylchloride with sodium arsenate	\$1 Comm. 55-70% conc. or 31.5% blended product	Crabgrass killer intermediate
Sodium p-aminophenyl arsenate	Abbott Labs	$AsO_2HNa \cdot 4H_2O$ 	White cryst. powder	Caustic neutralization of p-aminophenyl arsenic acid	Pharm.	For parasitic diseases of chickens, horses and swine
Sodium dimethyl arsenate (sodium cacodylate)	Mallinckrodt	$(CH_3)_2AsO_2Na \cdot 3H_2O$	White powder	Oxidation and neutralization of cacodyl oxide	\$16.10 Pharm.	Treatment of anemias
Phenyl arsenic acid	Abbott Labs	$C_6H_5AsO(OH)_2$	Crystalline powder M.P. = 160 C	The Bart reaction between the diazonium salt and sodium arsenite	Dev.	Reagent for tin
4-nitrophenyl arsenic acid	Dr. Salisbury's Labs Histostat	$AsO(OH)_2$ 	Crystalline solid	Nitration of phenyl arsenic acid	Pharm.	For treatment of turkey black-head disease.
2-Amino-4-arsenophenol hydrochloride	Parke, Davis Mapharsen	$AsO(NH_2) \cdot HCl$ 	White powder	Reduction of the arsenic acid derivative	Pharm.	Syphilotherapy
p-Carbamidobenzene-arsenic acid	Lilly Carbarsone	$AsO(OH)_2$ 	White powder	Coupling sodium arsenite with potassium cyanate	Pharm.	Amebicide
Octyl ammonium methane arsenate	Ansul Chemical, AMA Vineland Chemical	not a pure compound			Comm.	Crabgrass killer
4-Hydroxy-3-nitrobenzenearsonic acid	Abbott Labs	$AsO(OH)_2$ 	Pale-yellow crystals	Treating p-hydroxyphenyl arsenate with nitric and sulfuric acids	Pharm.	Growth stimulator for chicks
Dibromo(2-chlorovinyl) arsine	Lewisite	$ClCH=CHAsCl_2$	Colorless liquid B.P. = 196.6 and 169.8 C (2 isomers)	Condensation of arsenic trichloride and acetylene in the presence of copper or mercury chloride catalyst	\$0.28 Produced only in time of war	Gas warfare agent
Copper methane arsenate	Ansul Chemical	$[(CH_3)_2AsO_2]_2Cu$	Greenish solid	Reaction of cacodylic acid with copper salts	\$1.50 Dev.	Algicides
Silver methane arsenate	Ansul Chemical	$(CH_3)_2AsO_2Ag$	Brownish solid	Reaction of cacodylic acid with silver salts	Dev.	Algicides
Triphenyl stibine	Metal & Thermit Anderson Chemical	$(C_6H_5)_3Sb$	White crystalline solid M.P. = 53 C	Reaction of antimony trichloride with phenylmagnesium bromide or phenyl sodium	Dev.	Polymerization inhibitor catalyst; lubricating oil additive
Isopropyl antimonite	Anderson Chemical	$(i-C_3H_7O)_3Sb$	Colorless liquid B.P.(7mm) = 82 C	Reaction of antimony trichloride with isopropanol	\$20 Dev.	Cross-linking agent, flameproofing agent
Antimony potassium tartrate	Tartar emetic	$K(SbOH)_2C_4H_4O_6 \cdot \frac{1}{2}H_2O$	Transparent crystals	Reaction of potassium hydrogen tartrate with antimony trioxide	Comm.	Textile and leather mordant; treatment of schistosomiasis and leishmaniasis
Sodium antimony bispyrocatechol-2,4-disulfonate (stibophen)	Winthrop-Stearns Faudin		Fine crystals	Reaction of sodium pyrocatechol-3,5-disulfonate with antimony trioxide and precipitating with alcohol	Pharm.	Granuloma inguinale; veterinary use for dogs and sheep filaria

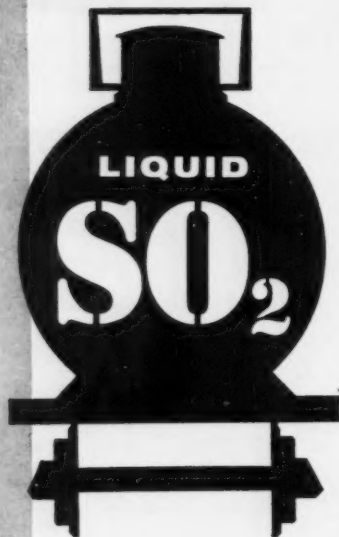
METAL ORGANICS OF GROUP V—(Continued)

Compound	Leading Producers and Trademarks	Formula	Physical Properties	Process	Price (\$/lb)	Major End-Uses
Stibamine Glucoside	Burroughs Wellcome Neostam	$\left[\begin{array}{c} \text{O} \\ \\ \text{C}_6\text{H}_{11}\text{O}_5\text{NHC}_2\text{H}_4\text{—Sb—O} \\ \\ \text{O} \\ \\ \text{C}_6\text{H}_{11}\text{O}_5\text{NHC}_2\text{H}_4\text{—Sb—O} \\ \\ \text{O} \\ \\ \text{C}_6\text{H}_{11}\text{O}_5\text{NHC}_2\text{H}_4\text{—Sb—O} \\ \\ \text{OH} \end{array} \right] \text{Na}$	Tan amorphous powder M.P. = d.	Condensation of 4-amino-benzene stibonic acid with glucose and precipitated with alcohol	Pharm.	Treatment of schistosomiasis, granuloma inguinale, and leishmaniasis
Triphenyl bismuth	Metal & Thermit	(C ₆ H ₅) ₃ Bi	White crystalline solid M.P. = 77.6 C	Reaction of bismuth chloride with phenyl magnesium bromide	Res.	
Bismuth subsalicylate	Mallinckrodt J. T. Baker McKesson & Robbins Chas. Pfizer N.Y.C.	C ₇ H ₅ O ₃ BiO	White powder M.P. = d.	Precipitated from solutions of bismuth nitrate or hydroxide and sodium salicylate or the acid	Pharm.	Med.—for treatment of syphilis; vet.—desiccant and astringent; intern.—for dyspepsia and diarrhea
Bismuth subgallate	Mallinckrodt J. T. Baker McKesson & Robbins Chas. Pfizer N.Y.C.	C ₉ H ₇ (OH) ₃ COOB(OH) ₂	Bright-yellow powder	Reaction of bismuth oxide and gallic acid	Pharm.	Med.—for treatment of skin diseases; vet.—for treatment of skin diseases
Bismuth p-glycolyl-aminophenyl arsanate (bismuth glycol Arsanilate)	Chemo-Puro Winthrop Labs. Polychemicals Labs.	$\begin{array}{c} \text{O} \\ \\ \text{NHCCH}_2\text{OH} \\ \\ \text{C}_6\text{H}_4 \\ \\ \text{HO—As—O—Bi—O} \\ \\ \text{O} \end{array}$	Yellowish-to-pink powder	Reaction of bismuth nitrate and sodium-p-n-glycolyl arsanilate	Pharm.	Med.—prophylaxis and treatment of intestinal amebiasis
Bismuth ethyl camphorate	Upjohn Co.	$\left[\begin{array}{c} \text{O} \\ \\ \text{CH}_2\text{—CH—COC}_2\text{H}_5 \\ \\ \text{C(CH}_3)_2 \\ \\ \text{CH}_2\text{—C—CO—} \\ \quad \quad \\ \text{CH}_3 \quad \quad \text{O} \end{array} \right] \text{Bi}$	Solid	Reaction of sodium ethyl camphorate and bismuth nitrate in glycerin solution	Pharm.	For treatment of syphilis

METAL ORGANICS OF TRANSITION ELEMENTS

Compound	Leading Producers and Trademarks	Formula	Physical Properties	Process	Price (\$/lb)	Major End-Uses
Tetraisopropyl titanate	Anderson Chemical Du Pont TPT	(i-C ₃ H ₇ O) ₄ Ti	Light-yellow liquid	Reaction of titanium tetrachloride with isopropanol	\$1 Comm.	Cross-linking agent; condensation catalyst; adhesion promoter
Tetrabutyl titanate	Anderson Chemical Du Pont TBT	(C ₄ H ₉ O) ₄ Ti	Light-yellow liquid	Reaction of titanium tetrachloride with butyl alcohol	\$1.30 Comm.	Cross-linking agent; condensation catalyst; adhesion promoter
Tetra(2-ethylhexyl) titanate	Anderson Chemical Du Pont TOT	$\left[\begin{array}{c} \text{C}_2\text{H}_5 \\ \\ \text{CH}_2\text{CH(CH}_2)_4\text{O} \end{array} \right]_4 \text{Ti}$	Light-yellow viscous liquid	Transesterification of isopropyl titanate with 2-ethylhexanol	\$1 Comm.	Cross-linking agent; condensation catalyst; adhesion promoter
Hydroxytitanium stearate	Du Pont TSTA	$\text{HO} \left[\begin{array}{c} \text{OOC}_{18}\text{H}_{35} \\ \\ \text{—Ti—O—} \\ \\ \text{OOC}_{18}\text{H}_{35} \end{array} \right] \text{H}$	Waxy solid M. P. = d.	Reaction of titanium ester with stearic acid	Dev.	Dispersant cross-linking agent; water repellent
Octylene glycol titanate	Du Pont OGT		Light-yellow solid	Reaction of butyl titanate with octylene glycol	\$1.10 Comm.	Cross-linking agent; surface-active agent
Titanyl acetyl acetonate	Mackenzie Chemical Anderson Chemical	$\begin{array}{c} \text{CH}_3 \\ \\ \text{TiO(OC=CHCOCH}_3)_2 \end{array}$		Reaction of titanium oxychloride with acetylacetone and sodium carbonate	\$6.50 Dev.	Cross-linking agent for cellulosic lacquers
Tetraisopropyl zirconate	Anderson Chemical	(i-C ₃ H ₇ O) ₄ Zr	White solid M. P. = d.	Reaction of zirconium tetrachloride with isopropanol	\$3 Dev.	Condensation catalyst; cross-linking agent
Tetrabutyl zirconate	Anderson Chemical Harshaw Chemical	(C ₄ H ₉ O) ₄ Zr	White solid M. P. = d.	Reaction of zirconium tetrachloride with butyl alcohol	\$0.60 Dev. 30% sol.	Condensation catalyst, cross-linking agent
Zirconium acetyl acetonate	Mackenzie Chemical Anderson Chemical	$\begin{array}{c} \text{CH}_3 \\ \\ \text{Zr(OC=CHCOCH}_3)_2 \end{array}$	White crystals M. P. = 194 C	Reaction of zirconium chloride with acetylacetone and sodium carbonate	\$7 Dev.	Catalyst for combustion, polymerization and condensation
Vanadium ethylate	Anderson Chemical	(C ₂ H ₅ O) ₃ V	Dark reddish-brown solid	Reaction of vanadium chloride with sodium ethylate	\$75 Res.	Polymerization catalyst

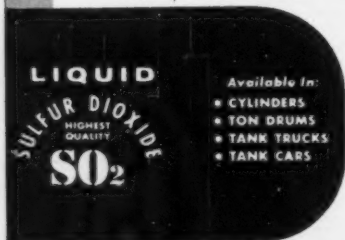
Vanadium acetyl acetonate	Union Carbide Anderson Chemical	$\begin{array}{c} \text{CH}_3 \\ \\ \text{VO}(\text{OC} = \text{CHCOCH}_3)_2 \end{array}$	Blue-to blue-green crystals M. P. = d.	Reaction of vanadyl sul- fate with acetyl acetone and sodium carbanote	\$9 Dev.	
Chromium carbonyl	Union Carbide	$\text{Cr}(\text{CO})_6$	Transparent solid M. P. = 149 C	Reaction of carbon mon- oxide with chromic chlo- ride and phenyl mag- nesium bromide	Dev.	Gas metal-plating production of metal powders; organome- tallic intermediate
Chromium acetyl acetonate	Mackenzie Chemical Anderson Chemical	$\begin{array}{c} \text{CH}_3 \\ \\ \text{Cr}(\text{OC} = \text{CHCOCH}_3)_3 \end{array}$	Red-violet crystals M. P. = 216 C	Reaction of chromium chloride with acetyl ace- tone and sodium carbon- ate	\$7.75 Dev.	
Methacrylate chromic chloride	Du Pont Rolan	$\begin{array}{c} \text{CH}_3 - \text{C} = \text{CH}_2 \\ \\ \text{O} \\ \\ \text{Cl}_2\text{Cr} \quad \text{O} \quad \text{CrCl}_2 \\ \quad \quad \\ \text{O} \quad \quad \text{O} \\ \quad \quad \\ \text{H} \end{array}$	Water-soluble solid	Reaction of methacrylic acid with basic chromic chloride	Comm.	Water repellant; nonadhesive; insolubilizer for vinyl poly- mers
Stearate chromic chloride	Du Pont Quilon	$\begin{array}{c} \text{C}_{18}\text{H}_{34} \\ \\ \text{O} \\ \\ \text{Cl}_2\text{Cr} \quad \text{O} \quad \text{CrCl}_2 \\ \quad \quad \\ \text{O} \quad \quad \text{O} \\ \quad \quad \\ \text{H} \end{array}$	Water-soluble solid	Reaction of stearic acid with basic chromic chloride	Comm.	Water repellant, nonadhesive
Phosphomolybdic methyl violet complex	Climax Molybdenum	$\left[\begin{array}{c} \text{N}(\text{CH}_3)_2 \quad (\text{CH}_3)_2\text{N} \\ \quad \quad \\ \text{C} = \text{C} \\ \quad \quad \\ \text{C}_6\text{H}_4 \quad \text{C}_6\text{H}_4 \\ \quad \quad \\ \text{NH}_2 \end{array} \right]_6 \cdot \text{P}_2\text{O}_5 \cdot 24\text{MoO}_3$	Dark-colored powder	Reaction of methyl violet with phosphomolybdic acid	Comm.	Color lakes and toners for inks, water colors, crayons, etc.
Manganic acetyl acetonate	Mackenzie Chemical Anderson Chemical	$\begin{array}{c} \text{CH}_3 \\ \\ \text{Mn}(\text{OC} = \text{CHCOCH}_3)_3 \end{array}$	Brown cryst. solid M. P. = 172 C	Reaction of a manganese salt with acetylacetone and sodium carbonate	\$3.75 Dev.	
Manganese ethylene bis-dithiocarbamate (MANEB)	Rohm & Haas	$\begin{array}{c} \text{CH}_2\text{NHCSS} \\ \\ \text{Mn} \\ \\ \text{CH}_2\text{NHCSS} \end{array}$	Brown powder M. P. = d.	Reaction of disodium ethylene bis-dithiocar- bamate with manganese salts	\$0.86 Comm.	Foliage fungicide
Methyl cyclopentadienyl manganese tricarbonyl	Ethyl Corp. AK-33X	$\text{C}_5\text{H}_5\text{Mn}(\text{CO})_3$		Reaction of methyl cyclo- pentadiene with man- gane carbonyl	Comm.	Gasoline additive
Ferric acetyl acetonate	Mackenzie Chemical Anderson Chemical	$\begin{array}{c} \text{CH}_3 \\ \\ \text{Fe}(\text{OC} = \text{CHCOCH}_3)_3 \end{array}$	Yellow powder M. P. = 182 C	Reaction of ferric sulfate with acetyl acetone and sodium carbonate	\$3.75 Dev.	Solid-fuel additive catalyst
Biscyclopentadienyl iron (ferrocene)	Du Pont	$\left(\begin{array}{c} \text{CH} = \text{CH} \\ \quad \quad \\ \text{CH} - \text{Fe} - \text{CH} \\ \quad \quad \\ \text{CH} = \text{CH} \end{array} \right)_2$	Orange-yellow crys- talline solid M. P. = 173 C	Reaction of ferris chlo- ride with cyclopentadienyl sodium	Comm.	Combustion improver
Ferric dimethyl dithio- carbamate (FERBAM)	Du Pont F. W. Berk Anderson Chemical	$[(\text{CH}_3)_2\text{N CSS}]_3\text{Fe}$	Black powder M. P. = 190 C with decomp	Reaction of sodium di- methyl dithiocarbamate with ferric compounds	\$0.39 Comm. 76% wetable powder	Foliage fungicide
Iron carbonyl	General Aniline	$\text{Fe}(\text{CO})_5$	Viscous amber yel- low liquid (pyro- phoric) B. P. = 103 C	Reaction of carbon mon- oxide on iron with am- monium hydroxide	Comm.	For production of powdered iron for cores in high-frequency coils
Cobaltic acetyl acetonate	Mackenzie Chemical	$\begin{array}{c} \text{CH}_3 \\ \\ \text{Co}(\text{OC} = \text{CHCOCH}_3)_3 \end{array}$	Dark-green crystals M. P. = 240.5 C	Reaction of coalous carbonate with acetyl acetone and peroxide	Dev.	
Cobalt naphthenate	Advance Solvents Harshaw Chemical Nuodex Products Wilco Chemical Ferro Chemical	$\left(\begin{array}{c} \text{CH}_2 - \text{CH}(\text{CH}_2)_n\text{COO} \\ \\ \text{H}_2\text{C} \quad \\ \\ \text{CH}_2 - \text{CH}_2 \end{array} \right)_2 \text{Co}$	Bluish-red solid	Reaction of cobalt sulfate with sodium naphthenate	Comm.	Paint drier
Nickel carbonyl	International Nickel	$\text{Ni}(\text{CO})_4$	Yellow volatile liquid B.P. = d.	Reaction of carbon mon- oxide with finely divided nickel	Used captively only	In the Mond process for nickel production
Nickel acetyl acetonate	Mackenzie Chemical	$\begin{array}{c} \text{CH}_3 \\ \\ \text{Ni}(\text{OC} = \text{CHCOCH}_3)_3 \end{array}$	Green crystals M. P. = 228 C	Reaction of nickel chlor- ide with acetyl acetone and NH_3	Dev.	



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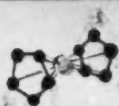
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METAL ORGANICS

of magnetic recording tape and as dielectric coating in other electrical applications; it also forms thixotropic gels.

Certain metal organics — especially the magnesium Grignards—have long been recognized as commercially important intermediates in synthesis of other chemicals that are not metal organics; often overlooked is the variety of ways in which metal organics are used as stepping stones to other metal organics.

For example, magnesium Grignards such as methylmagnesium chloride and phenylmagnesium chloride are used to make methyl- and phenyl silicones and silanes.

Diethyl zinc is used to make fungicides—e.g., ethyl mercuric chloride; Ethyl Corp.'s new tetraethyl lead process utilizes diethyl cadmium as intermediate ethylating agent; tetraethyl lead is used as an alkylating agent in making alkyl mercurials from mercury salts.

Triethyl aluminum is used to make triethylborane, diethyl zinc and tetraethyl lead (new Ziegler process). Ferrocene is made from cyclopentadienyl sodium.

Organo-Aluminums: Other compounds—notably triethyl aluminum (TEAL) and triisobutyl aluminum (TIBAL)—are now riding the crest of popularity as established catalysts in Ziegler polymerization processes.

Demand for the catalysts will, of course, depend on what types of polymers are made. In case of stereospecific Ziegler and Natta polymers, a polymer ratio of 1,000 to 1 is assumed (but 500 to 1 is practical); this means that 1 lb. of catalyst will produce 1,000 lbs. of polymer.

Combined production of polyethylene, polypropylene, poly-1-butene, polyisoprene and polybutadiene may reach the 1-billion-lbs./year level soon and consume 1 million lbs./year of TEAL in the process. Polyethylene output alone is expected to climb to some 1.7 billion lbs./year by '65 (*CW*, May 9, '59, p. 82); conservative predictions put polypropylene output at 420 million lbs. by that time (*CW*, Nov. 14, '59, p. 67).

Hercules Powder originally was sole licensed U.S. producer, of aluminum trialkyls for sale (under Ziegler pat-

ents). Hercules and Stauffer Chemical have since formed a joint company—Texas Alkyls Inc.—to make aluminum alkyls; a \$1-million, 2-million-lbs./year plant went onstream in late '59 on the Houston Ship Channel in Texas. It's now turning out triethyl- and triisobutyl aluminum; meanwhile facilities are being expanded for manufacture of other aluminum trialkyls, aluminum alkyl chlorides and hydrides.

Others interested in production of aluminum alkyls include Ethyl Corp. (the firm has advertised aluminum alkyls for sale and is jockeying for improved patent position) and Union Carbide.

Use of triethyl aluminum isn't limited to polymerization reactions; Continental Oil's process for making Alfol straight-chain primary alcohols (the firm's new plant is due onstream in '61) will use TEAL as intermediate. The compound will also be used to make alpha-olefins.

There are, of course, other aluminum organics—besides TEAL and TIBAL—which have catalytic properties. Some now available in development quantities: diethyl aluminum chloride, diethyl aluminum hydride, tripropyl aluminum, triisohexyl aluminum.

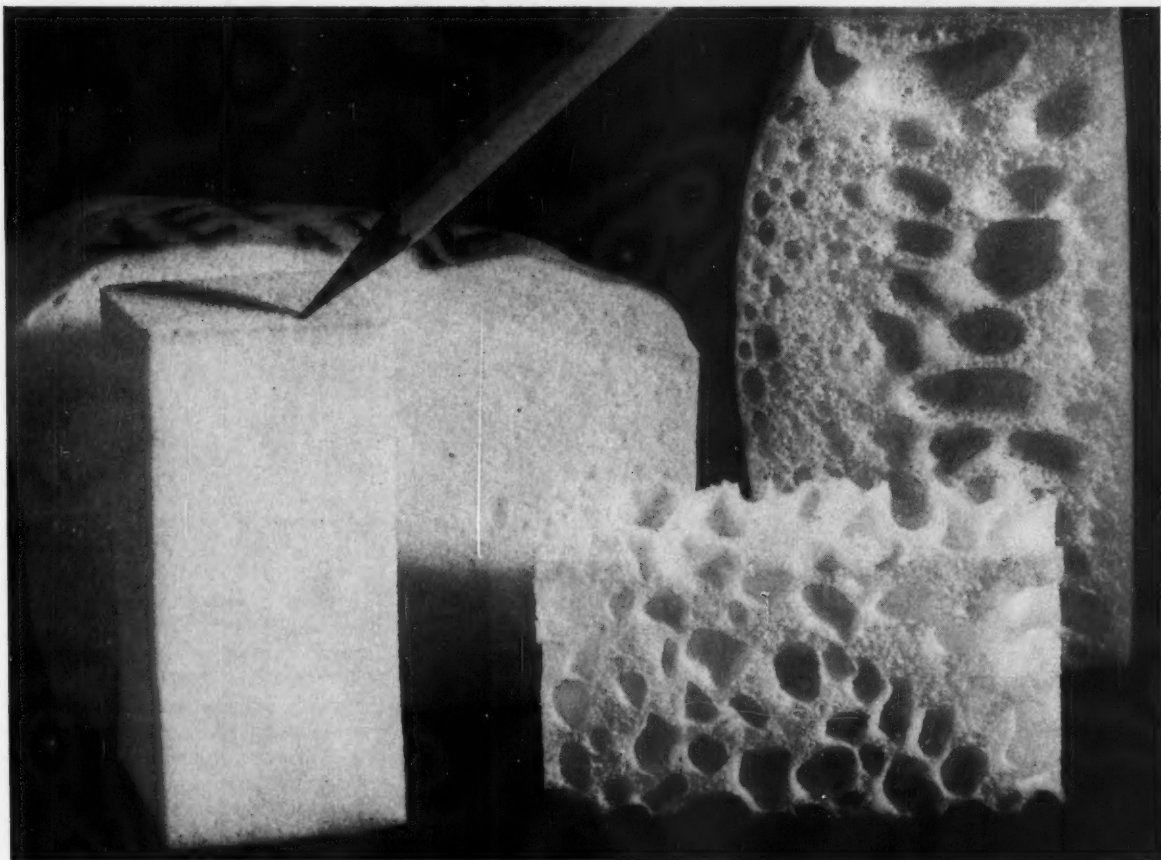
Aluminum isopropylate (aluminum isopropoxide) is made on commercial scale, for sale, by Chattem Chemical, Anderson Chemical Division of Stauffer, and Harshaw Chemical. The compound is used as a specific reducing agent of aldehydes and ketones (Meerwein - Ponndorf - Verley method).

Harshaw has also developed an aluminum chelate based on aluminum isopropylate; it may find use as a cross-linking agent, as hydrophobic intermediate, drying oil modifying agent, adhesion promoter.

One intriguing noncatalytic use for organo-aluminums is in pyrophoric (self-igniting) fuels in ramjet missiles and high-altitude, jet-flame sustainers in turbojet engines.

They may also become important in production of other metal organics of tin, silicon, lead, zinc, boron. Certain aluminum organics may be used for gas plating of aluminum on steel, production of fine aluminum powder

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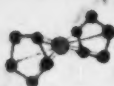
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METAL ORGANICS

for explosives and high-energy fuels, and as reducing agents—alkyl aluminum hydrides, for example, are relatively inexpensive (\$2/lb.) replacements for more expensive (\$10/lb.) lithium aluminum hydride and sodium borohydride.

Boron Breakthrough Delayed: Boron-based fuels have suffered a decided setback due to the recent military cancellation of orders. Nevertheless, these fuels are not being counted out; they have about 40% higher energy content than the best available jet fuel. (Boron fuel has a heat content of 25,000 Btu. lb. of fuel, compared with 18,000 Btu. for conventional jet fuel.)

Both plants of Olin Mathieson and Callery Chemical were shut down because cost of the boron fuels was 20-50 times more than for hydrocarbon fuels. However, the U.S. Industrial Chemicals-American Potash and the Stauffer-Aerojet ventures are moving toward new pilot plants and new processes. Estimated costs of using at least one of these processes are quite attractive and may, in large-scale production, compare favorably on a Btu. basis with conventional fuels.

(Incidentally, triethylborane is also one of the compounds proposed as fuel for the Air Force's new target drone missiles, the Redhead and the Roadrunner.)

Of the present commercially available metal organic compounds of boron, methylborate is probably most widely used. Aside from captive use to make high-energy boron fuels, it's used extensively in gas-brazing fluxes, as inert gas blanket in metal treating, as Lewis acid catalyst, neutron detector, component in azeotropic systems for hydrocarbon purification, specific solvent, liquid source of boron oxide, and in testing prototype aircraft engines for eventual use with high-energy boron fuels.

Producers of methylborate are Anderson Chemical, Pacific Coast, Trona, Metal Hydrides, Callery, Montrose.

Trimethoxyboroxine — a high-boron-content derivative of methylborate—is also used in these fuel applications, and as a fire extinguisher fluid for metal fires.

Another commercially important boron organic is Sohio's boron additive, a complex glycol borate; it's now also used by DX Sunray and Richfield Oil.

Meanwhile a host of other boron organics are either used in limited quantities for special purposes (e.g., sodium tetraphenylborine, a gravimetric reagent for potassium, etc.) or are offered to the CPI in developmental quantities.

These include other alkyl borines and boroxines, some alkyl and aryl boronic acids, substituted borazoles derived from the parent compound, borazole ($B_2N_2H_6$), which is very similar to benzene (they are isoelectronic and have approximately the same molecular weights).

SODIUM AND LITHIUM

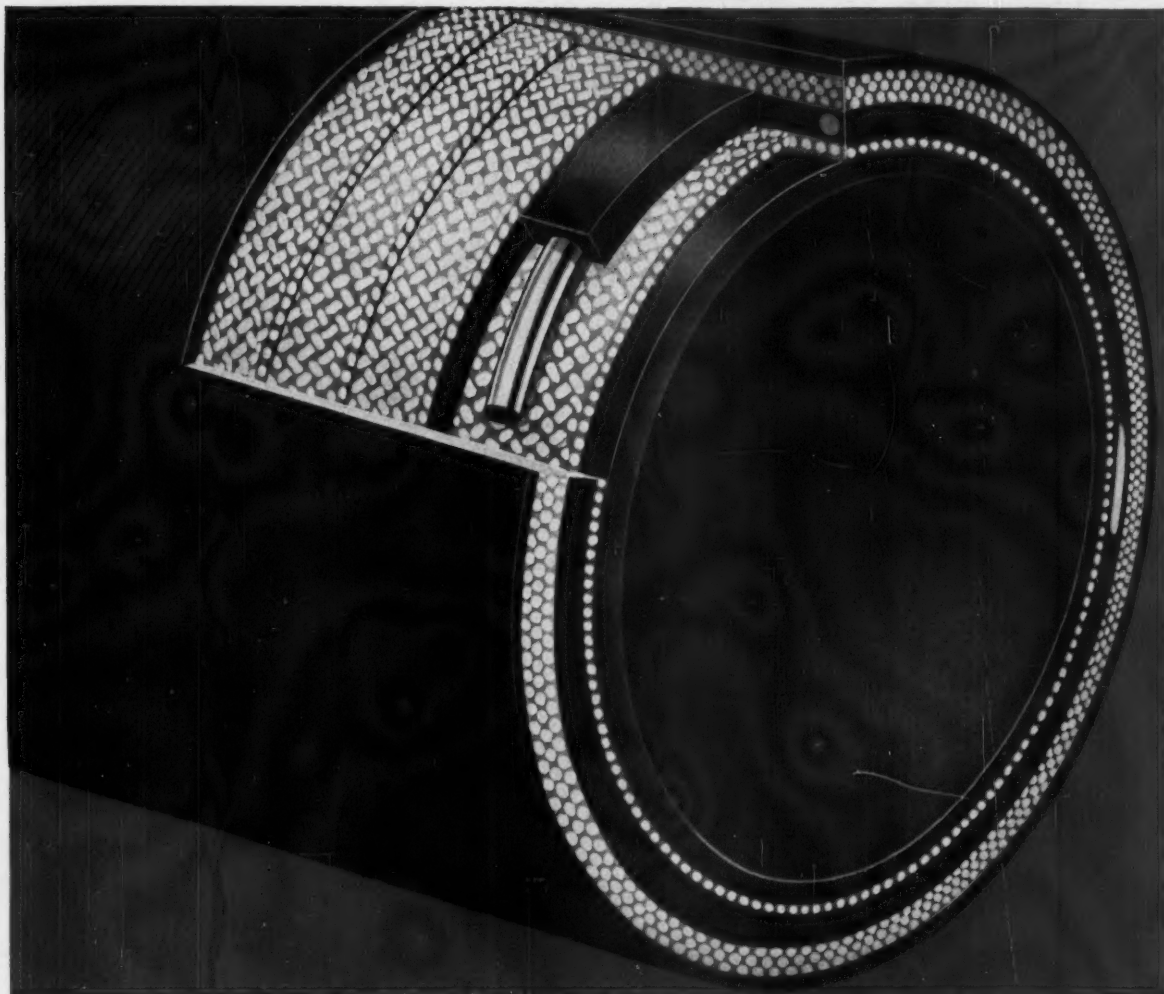
Sodium organics are commercially important primarily as intermediates in synthesis of other compounds, especially for use in pharmaceuticals and insecticides. Much of the estimated 15-million-lbs./year demand for sodium alcoholates (alkoxides) is for captive production of fatty alcohols by reduction of hydrogenated tallow and coconut oil. Some sodium alcoholates are, however, sold on the open market.

In general organo-sodium compounds haven't done well. The potential 10-million-lbs./year demand for disodiooctadiene in manufacture of isosebacic acid disappeared when U.S. Industrial Chemicals "temporarily" closed its isosebacic plant at Tuscola, Ill., in '59. If isosebacic acid comes back—as USI believes it will—the sodium organic will come into its own.

The lithium organic attracting most attention at the moment is n-butyl lithium (dissolved in normal heptane); it's aimed mainly for use in stereo-specific polymerization of butadiene and isoprene.

Firms making the chemical are Foote Mineral, Lithium Corp. of America, American Potash, Anderson Chemical.

High price has been a handicap and producers must emphasize n-butyl lithium's unique performance characteristics. However, earlier this year (*CW Market Newsletter*, March 26) one producer cut the price of the com-



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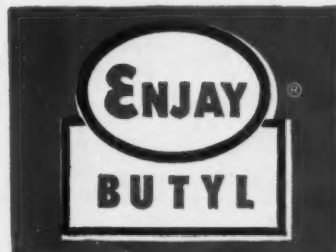
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pound from \$18.50/lb. to \$12/lb. in lots of 500 lbs. or more; since then the price has dropped still lower and some firms reportedly are now selling at less than \$9/lb.

MERCURY: UP AND DOWN

Mercury organics—first prepared about a century ago—have long been on the consumer market in the form of household antiseptics such as Mercurochrome (the disodium salt of dibromohydroxymercurifluorescein), Metaphen (anhydride of 4-nitro-3-hydroxymercuri-o-cresol) and Merthiolate (sodium ethylmercurithiosalicylate). Although still in use to some extent because they are non-irritating, their market is on a rapid decline because of competition from more effective materials—e.g., hexachlorophene, antibiotics.

Mercurials are also used as diuretics; most effective compounds are methoxymercuration products of allyl amides such as Mercuhydrin (sodium 3-hydroxymercuri-2-methoxypropylsuccinylurea) and Chlormerodrin (3-chloromercuri-2-methoxypropylurea).

Whereas many medicinal markets for mercury organics are declining, pesticide uses are growing. Some uses: methyl mercuric hydroxide is used on seeds to prevent wheat smut; phenyl mercuric acetate is used as antibacterial agent in water-base paints, in control of weeds, turf and seed diseases, and in control of slime organisms in pulp and paper processing.

Phenyl mercuric acetate (PMA) is a major item among organic mercurial pesticides. Production increased to more than 1 million lbs. in '58 (latest U.S. Dept. of Agriculture data available), from 570,000 lbs. in '57. A variety of other organic mercurials accounted for an additional 612,000 lbs. of mercurial output in '58, representing a substantial increase from 540,000 lbs. in '57. (Incidentally, USDA reports that 476,520 lbs. of mercury metal—12.1% of total U.S. consumption—were used to make pesticides in '58.)

Pesticide Problem: Use of metal organics for seed treatment (as fungicides) is expected to hold up well; but metal organics used as foliage pesticides are facing an uphill fight.

There's a good chance that these markets will dwindle significantly—with possible exception of tin organics for which some experts profess considerable optimism.

Like many other types of pesticides, metal organics are bound to be affected by growing concern about pesticide residues on foodstuffs (as emphasized last year by the cranberry fiasco).

Nonetheless there's no real fear that metal organics will be completely eliminated from the agricultural scene, even in foliage pesticide applications.

ARSENIC: JEKYLL-HYDE

For years, markets for organic arsenic compounds have fluctuated erratically, largely because of periodic military needs. Lewisite—the poison gas made in volume for both world wars but never used—is chlorovinyl-dichloroarsine. Other arsenic-based war gases are diphenylchloroarsine (Blue Cross) and phenarsazine chloride (Adamsite).

Commercial uses for arsenic organics have grown modestly but steadily, although individual compounds in some cases have suffered competitive pressures. Case in point is disodium methyl arsonate, a common ingredient in crabgrass killers; output of the chemical dropped from 618,000 lbs. in '57 to 368,000 lbs. in '58 ('59 data is not yet available).

The decline probably results from competitive pressures of new chemicals such as chlordane and to some extent from inorganic arsenic compounds (e.g., lead arsenate, sodium arsenite, tricalcium arsenate). But as a group organic arsenicals aren't to be written off yet for herbicides, for example; one new crabgrass formulation contains 8% (by weight) of octyl ammonium methyl arsonate and 8% dodecyl ammonium methyl arsonate — that represents about 4.2% of elemental arsenic content.

Organic arsenic compounds go into a number of other uses such as veterinary treatment of parasitic diseases of chickens. Historically notable is Paul Ehrlich's Salvarsan 606 (3,3'-diamino-4,4'-dihydroxyarsenobenzene), the curative for parasitic diseases such as syphilis and sleeping sickness. Admittedly this and similar

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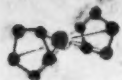
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METAL ORGANICS

Meet the Author



Amos R. Anderson is president and technical director of Anderson Chemical Division of Stauffer Chemical Co.; he is also president and chairman of the board of Texas Alkyls, Inc., which is owned jointly by Stauffer and Hercules Powder.

After earning a B.S. (in '42) from Adrian College and pursuing graduate studies at Ohio State University, "Andy" Anderson did catalytic research for Girdler Corp. In '44 he joined the Navy but was released from active duty to work on the Manhattan Project. This was followed by a short research stint with Parker Rust Proof Co.

In '46 Anderson organized Anderson Laboratories, which in '59 — then known as Anderson Chemical Co. — was merged with Stauffer. As key man in the 14-year-old metal organics manufacturing firm he is well qualified to speak authoritatively about current and future metal organic markets.

compounds are gradually being replaced by newer drugs.

High toxicity often prevents use of otherwise effective drugs. Some antimony compounds, for example, are effective against spirochetes and trypanosomes but can't be used because they are too toxic. Most widely known organic antimony compound is potassium antimonyl tartrate — better known as "tartar emetic." It was used extensively to combat Leishmania parasites and schistosomes but has been replaced in the past few years by two new antimony organics, stibamine glucoside (Burroughs Wellcome Co.'s Neostam) and sodium antimony bis-pyrocatechol-2,4-disulfonate (Winthrop-Stearns' Fuadin); the latter compound is also used by veterinarians to control dog and sheep filaria. Another antimony compound, sodium *p*-stibanilate, is used for treatment for kala azar—a parasitic disease common in southern Asia.

Organo-bismuth compounds resemble those of antimony but are considerably less stable; nondrug commercial applications have not

yet developed although some bismuth-vinyl derivatives may become of value for polymer and copolymer formation through their vinyl groups.

Pharmaceutical use of bismuth organics—mainly in treatment of intestinal infections—started in 1921; the chemicals were soon found to have both spirocheticidal and spirochetostatic effects and consequently were used worldwide in the treatment of syphilis. Some are still in use—e.g., bismuth subsalicylate and bismuth sodium thioglycollate (Thio-Bismol, made by Parke, Davis). Their use has also extended to veterinary desiccants and astringents, and for treatment of dyspepsia and diarrhea.

TRANSITION TRENDS

A large number of elements—including the so-called transition elements — were back-benched by organo-metallic chemists until about '47; since then, several important developments have helped bring these elements to the fore.

Discovery of sandwich-type compounds (see chart, p. 55)—in particular, dicyclopentadienyl iron (fer-



METAL ORGANICS

rocene) by Kealy Pauson and Miller/Tabboth Tremain — opened up an entirely new phase of metal organic chemistry.

Metal organic chemistry was given another push through discovery of a practical method of producing alkyl titanates (by Nelles of I.G. Farbenindustrie) followed by applications developments by Du Pont, National Lead, and others.

Another boost came from discovery, by Ziegler and Natta, that olefins could be polymerized at low pressures, using catalyst systems comprising in part the transition elements in various organo-metallic combinations.

Listing commercial applications of all metal organic compounds of all transition elements would be a major undertaking; but a mention of selected examples will serve to reveal the wide range of applications and commercial significance of these compounds.

Iron, Manganese, Zinc: Industrial significance of these three metals—in metal organic compounds—is underscored by the 8-10-million-lbs./year sales of three compounds used as foliage fungicides: manganese ethylene bis-dithiocarbamate, ferric dimethyldithiocarbamate, zinc ethylene bis-dithiocarbamate.

Iron metal organics are of particular interest because of low cost factors. Discovery of ferrocene—and its ability to promote nearly smokeless combustion of organic materials, e.g. fuel oils—spurred the synthesis of a flood of new derivatives of the compounds; so far only a few have reached commercial stage. Recently synthesized silanoxyl ferrocenes may have potential uses as high-temperature stable fluids for military and industrial purposes.

More familiar on the industrial scene are such iron organics as the ferric alkoxides (notably ferric ethoxide, isopropoxide, and n-butoxide) used as polymerization catalysts, resin-hardening agents, paint and varnish formulation.

Ferric salts of organic acids are used in pigmented films for organic coating compositions; ferric formate is used to make finely divided metallic iron (for magnet making); ferric

stearate is an additive for oil-base drilling fluids. The iron chelate of ethylenediamine tetra-acetic acid is used to correct chlorosis (iron deficiency) in plants.

Another commercial manganese organic is methylcyclopentadienyl manganese tricarbonyl; because it's non-toxic, it can be used in unlimited quantities as antiknock supplement to tetraethyl lead. Ethyl Corp. makes the compound (called AK-33X) at Orangeburg, S.C.

Cobalt and Nickel: A host of metal organic compounds of cobalt and nickel have been made; many are of commercial importance, add up to a 10-15-million-lbs./year market.

These include carboxylic acid salts used as paint driers and catalysts, carrying agents for polyester resins, surface detackifiers for polymerized and saturated hydrocarbons; most commonly used are the octoates, taloates, naphthenates. Nickel formate and acetate are sources of nickel metal for hydrogenation catalysis.

Nickel and cobalt chelates have various industrial uses. The acetyl acetonates, for example, improve stability and air hardening of plastics and adhesives, may be used as catalysts, fuel additives, gaseous nickel plating of aluminum.

Salicylaldehyde ethylenediamine cobalt (Salcomine)—also a chelate—is an effective accelerator for vulcanizable organic polymers, aid air oxidation of mercaptans in petroleum, removes dangerous peroxides from solvents.

Nickel chelates of methyl methacrylate copolymer and chelates of 2 (phenylazo-*p*-cresol) and phenylazo-2-naphthol protect synthetic rubber from ultraviolet-light degradation, are thermal antioxidants in polymers.

Cobalt and nickel form a host of other compounds of commercial or development interest; they range from cobalt complex of ethylene bis-(imidodiacetic) acid-used to stimulate production and regeneration of human blood—to cobalt and nickel phthalocyanines, which behave as semiconductors at elevated temperatures.

Titanium, Zirconium: Titanium organics are rapidly finding many industrial uses. Butyl titanate, for example, was first used to check cracking



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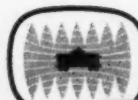
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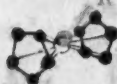
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CW REPORT



METAL ORGANICS

and powdering of paints, is used in combination with aluminum powder in formulation of heat-resistant paints (for smokestacks, etc.), goes into anti-fouling compositions.

Alkyl titanates in general are used as gelling, curing and drying agents for natural resins, epoxy resins, alkyls and silicones. Some types are good waterproofing agents, water repellants for leather, paper, textiles, masonry. About a carload/month of alkyl titanates are now used as water repellants.

Other uses of alkyl titanates: adhesion promoters (paints, plastic films); antibleeding agents (inks, dyes); polymerization and cross-linking catalysts. Chloroalkyl titanates (along with aluminum alkyls) are used in polymerization of ethylene, propylene, and other olefins, and in one method of preparing linear polycarbonates. Butyl titanate is a catalyst for preparation of phthalocyanines and in ester interchange reactions.

Applications of zirconium organics—notably butyl zirconate—are finding applications similar to those of alkyl titanates; often they form more stable compounds and complexes than the corresponding titanium chemicals and are preferred in many water-repellant formulations.

And Many More: Random probing of the seemingly inexhaustible metal organics grab-bag turns up these further compounds that point up diversity of metal organic uses:

Molybdenum nitrogen-bonded chelates are used in lakes and toners for printing inks, crayons, toy enamels; other oxygen-bonded chelates go into metal coatings (phenolic complexes). Potential uses for molybdenum compounds range from dyes and catalysts to modified resins and vapor-plating applications.

Water-soluble chromium complexes of carboxylic acids are sold by Du Pont (under the tradenames Volan and Quilon) as surface modifiers for finishing paper, glass fibers, leather, textiles, etc., to aid bonding of organic coatings.

Certain thermolabile organo-copper compounds, such as copper alkyls, may provide means of producing free-radical fuels for use in weapons.

The commercial future of the metal organics industry must, of course, be based on continuing fundamental chemical research aimed at synthesis of new compounds and study of their properties.

Research grants sponsored by chemical firms reveal the CPI's awareness of this need. Recently, for example, Dow Corning awarded a \$27,380 grant to Lee Harry Sommer of Pennsylvania State University for support of continued research on organo-silicon chemistry (Sommer has already synthesized and studied more than 1,000 organo-silicon compounds).

Another grant (of \$22,192) was provided by Koppers Co. to Thomas Wartik—also of Penn State—for continuance of research on boron and aluminum alkyl hydrides and related compounds.

The supply of metal organics turned out by research laboratories are getting increasingly careful perusal for market development prospects; many compounds are still in the blue-sky realm and may never (as is likely with high-priced gold and silver organics) reach volume markets, or will be developed for a long time.

But from this storehouse many compounds will undoubtedly emerge rapidly into commercial importance as the metal organics business moves into the CPI as a major markets arena.

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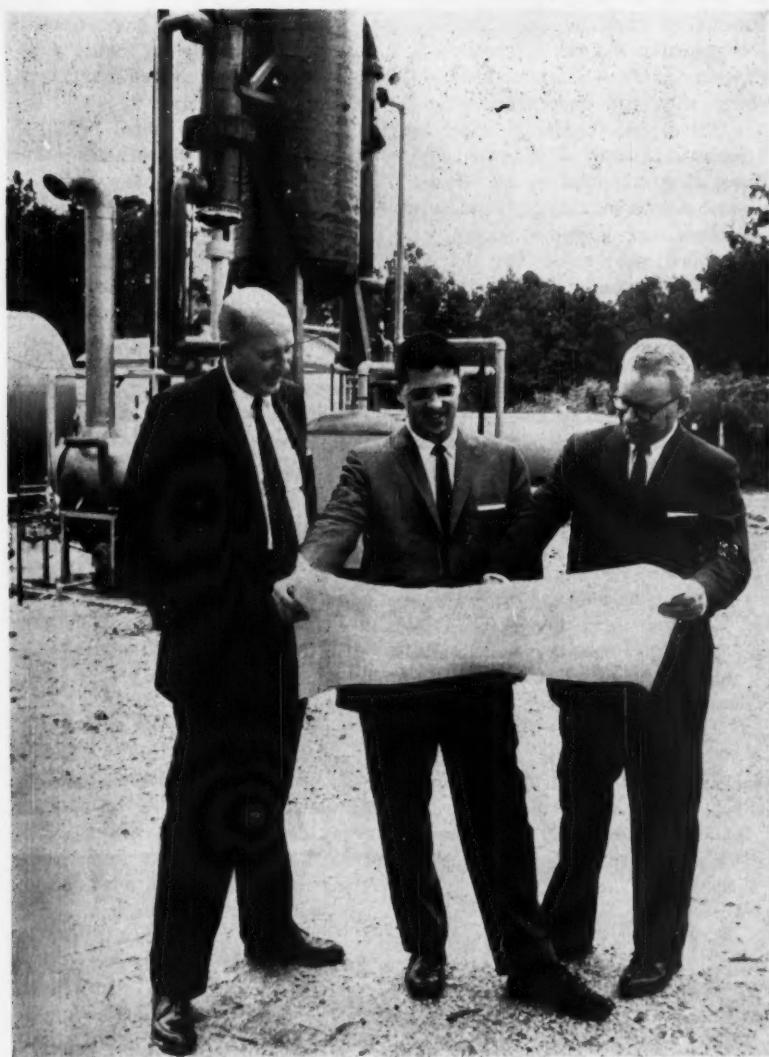
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Dixie's Morian, Priest and Bowen inspect plant expansion plans.

CW PHOTO—R. HOSACK

Dixie: Maverick on the Move

In the next few weeks Dixie Chemical Co. will put onstream a 2,800-lbs./hour fractionating column at its 15-acre Houston plant. This unit—along with a similar but somewhat smaller column to be installed later—will be used for the custom processing of chemicals. It's another stride by Dixie toward the role of chemical processor.

Founded postwar as a distributor of industrial chemicals, the company has successively branched into other areas such as formulation of drilling mud and other oil-industry chemical

specialties, filling of ammonia and chlorine cylinders, formulation of chemical specialties such as pentachlorophenol wood-treating chemicals, and custom processing of off-grade materials. In doing this the company has boosted sales to almost \$2 million/year and put together a management group that appears geared to handle sales far in excess of the firm's present level.

The New Look: Besides the installation of the new fractionating columns, Dixie has made several moves this year that have pushed it

deeper into processing. This spring, two vacuum flash stills of 1,300-lbs./hour and 660-lbs./hour capacity were installed for the recovery and upgrading of chemicals by removing minor impurities. The larger unit handles mixtures of glycols from petrochemical plants and oil refineries; the smaller unit is used in recovery of solvents such as ketones, alcohols, esters and other hydrocarbons from wash solvents used by paintmakers.

More Manpower: Besides putting more equipment onstream Dixie Chemical has also made some significant moves on its management level. Last May the company appointed a new vice-president, Ken Bowen, placed him in charge of all petrochemical processing operations, including supply, sales and engineering-design. Bowen was a former plant manager of Dow's styrene operation at Freeport, and was also plant manager of Celanese's Bishop, Tex., plant and a vice-president and general manager of Texas Butadiene & Chemical Corp. in Houston.

Another fairly recent newcomer to the company is Jerry Priest, a physical chemist who formerly was with Humble Oil & Refining. He joined Dixie in '57 when the firm became a licensee of Humble for production of an oil-in-water emulsion used as a nonplugging oil well completion fluid. Priest, who did most of the development work on that process at Humble, set up for Dixie the necessary processing equipment to make the fluid. After getting this under way, he was named manager of research and development at Dixie, responsible for exploring opportunities for recovering and upgrading by-product, waste product and coproduct streams from chemical and petrochemical operations and oil refineries in the Southwest.

Still a Distributor: Although the company is placing heavy emphasis on its processing potential, it isn't abandoning its position as a distributor of chemicals. It's now selling about 130 different products from 20 principal suppliers. About 60% of gross sales are under the Dixie label.

Tracing Dixie's evolution as both a distributor of industrial chemicals and as a custom processor of off-grade chemicals begins in '45, when

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SPECIALTIES

the company was started by Stanley C. Morian, its present president and controlling stockholder. He left his job as district engineer of the Dowell Division of Dow Chemical and — along with two incorporators and \$10,000 capital—organized Dixie as a jobber-distributor of industrial and heavy chemicals used in the oil and petrochemicals industry, and specialty chemicals such as drilling muds.

The first move away from that of chemical distributor came in '46, when Argentine quebracho—a source of tannins for use as a dispersing agent for oil field natural clay drilling muds—was in short supply and high priced. Dixie began developing a substitute tannin from mangrove bark; later, using a licensed process, it turned out a 66% sodium tannate solution by reacting caustic soda and pecan shell tannins.

In '50 the company acquired part of Mathieson Chemical Corp.'s chlorine and ammonia filling facilities, now has the largest cylinder filling operation in the Southwest.

The company moved closer to chemical processing in '51, when it won a contract to supply 500,000 gal. of emusifiable concentrates of toxaphene, aldrin and dieldrin.

Some materials Dixie has processed or formulated on a custom basis for chemical companies in the Southwest include such chemical specialties as epoxy resin solutions, pesticides, detergents for milk processors, phosphate-chromium complexes and methanol-glycol solutions.

Many of his customers, says President Morian, began to ask if he might have "a little piece of equipment such as a vacuum unit that could clean up 'dirty' solutions." So, he says, he added two, not one, vacuum stills to his Dixie operation.

Processing Promise: Morian tells CHEMICAL WEEK that Dixie "plans to continue to make the chemical distributing end of the company strong—to complement our new interest in custom processing, upgrading and recovery of specialty chemical materials." But it now seems that the company's biggest potential is in making, not selling, chemicals. If the company keeps up its present fast rate of growth, the near future should find it a potent contender for much of the reprocessing chemical business throughout the Gulf Coast area.

New Enzyme Entry

A new enzyme for pharmaceutical use, and eventually for industrial applications, will be entered in the \$100-million enzyme market by Wallerstein Laboratories (Staten Island, N.Y.), division of Baxter Laboratories (Morton Grove, Ill.), in a few weeks.

Cellase 1000 is claimed to be the first high-potency cellulolytic enzyme commercially available in the U.S. and the purest yet produced. A fermentation product of *aspergillus niger*, the enzyme is described as a protein molecule, which depolymerizes cellulose.

It is the third in a series of digestive enzymes developed by Wallerstein (others are Mylase 100 and Prolase 300).

First, and probably most important, use will be by pharmaceutical companies for products to aid digestion of cellulose. More specifically, Wallerstein envisions the product prescribed for people with ulcers, indigestion, malnutrition and bad dentures. Geriatrics and pediatrics offer big potential use of the enzyme.

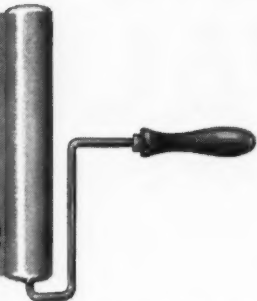
Another possibility for Cellase 1000 will be the food processing industry. The enzyme falls into a category already accepted by the U.S. Food & Drug Administration for use in foods.

Initial price is being quoted at \$1/-gram or \$454/lb. Wallerstein points out, however, that dosage would amount to only 1-4 milligrams. The company also plans to offer a technical grade of the material, tentatively labeled Cellzyme, for industrial uses in the paper and textile industries. No definite date has been set for introduction of the cheaper, impure material; the company says it will be made available if interest develops.

Cellase 1000 has a more exotic aspect as well. It could have possible application for space travel in digestion of algae food sources.

Several cellulolytic enzymes are currently being marketed in Europe. Farbwerke Hoescht AG. (Frankfurt, Germany) has been selling a product called Festal for three or four years, and Luitpold (Munich) is offering Luiszyme. Both products, however, are said to be mixtures of amylase, proteolase, and cellulase. Wallerstein reports that its Cellase 1000 is several-fold more potent than any European product.

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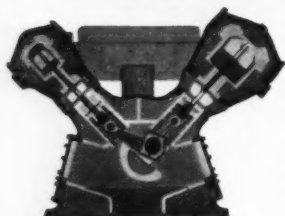
SPECIFICATIONS FOR CSC AMP

Neutral Equivalent	88.5-91.0
Color, APHA, max.	20
Water, by Wt., max.	0.8%
Distillation Range	156°C-177°C
below 161°C max.	10%
above 168°C max.	5%
Odor	Characteristic
Non-volatile Matter by Weight, max.	0.005%

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As you decide which 24 values are real, remember that they're not the obvious characteristics that show up on pressure gauges or price tables. They are true "values" that reveal themselves in your maintenance records ten years hence—when you find out that "those Worthington's are least expensive to run." Next time you specify a compressor, please see your local Worthington representative. Worthington Corporation, Compressor and Engine Division, Buffalo, N. Y. 36-9



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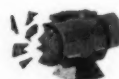
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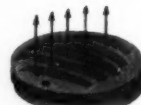
ASME DESIGN INTER-COOLER of straight tube construction externally mounted, is readily accessible.



CHOICE OF DRIVE—Flange mounted, Multi-V belt or direct coupled with tapered shaft, easy mounting.



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REMOVABLE DOWEL locks piston rod to crosshead—prevents turning due to loosened crosshead nut.



ULTRASONIC TEST—an advanced method of examining certain critical parts for internal quality.

Technology

Newsletter

CHEMICAL WEEK
September 17, 1960

Highlights of the 138th National American Chemical Society
meeting in New York this week:

- Reaction of polycyclic 1,3 conjugated compounds (obtained from conifers) with unsaturated polyesters provides new resins having unusual properties (e.g., light weight, high strength), according to U.S. Rubber's Naugatuck Chemical Division.

- Low-viscosity polyesters suitable for making high-solid, oxidizer-loaded urethane propellants include neopentyl glycol sebacate, neopentyl glycol azelate, neopentyl glycol dimer acid polyesters, tripropylene glycol azelate, etc., according to work at Aerojet-General Corp.'s Solid Rocket Plant (Sacramento, Calif.). Implication: the polyesters may also be suitable to prepare polyurethanes containing pigments, carbon black or fillers, for use in tiles, hoses, molded articles, tires, and the like.

- Selenium and selenium compounds (e.g., dibenzylselenourea) in rubber compounding were investigated at Battelle Memorial Institute. Replacement of sulfur with selenium improved aging properties of SBR. Heat resistance of several polymers was improved by the compounds.

•
The volume of overseas work handled by British engineering firms is gaining on that of their U.S. competitors, says Britain's Board of Trade. From March '59 to March '60, 67 British contractors handled \$347.2 million of business in foreign countries, compared with an estimated \$800 million handled by 300-400 American firms—increases since '56 of about 80% for the British, about 10% for the Americans. Most of the British work is being done in Australia and Canada, where it amounts to about \$36.4 million and \$84 million, respectively.

•
The McGraw-Hill Encyclopedia of Science and Technology debuts Oct. 3. Providing wide coverage of sciences and engineering, the 15-volume, 8,500-page work will list at \$159 until Nov. 15, then rise to \$175. Text is supplemented by 9,700 illustrations.

•
Latest move in the TEL-TML affair: Du Pont will market a new gasoline additive called Tetramix, which the firm says appears to work better than either tetraethyl or tetramethyl lead (on a lead metal weight basis) at all concentrations. It's a mixture of TEL, TML and methyl ethyl lead compounds. Commercial quantities are available from new facilities at Deepwater Point, N.J. (*CW*, Sept. 3, p. 23). Du Pont has applied for a process patent on the additive, which will be marketed along with Du Pont's regular TEL and TML.

•
As a large phosphate producer, North Carolina may soon be competing with Florida (*CW*, Aug. 27, '60, p. 69), if a still experimental

Technology

Newsletter

(Continued)

recovery technique proves out. According to State Geologist J. Stuckey, success hinges on an underground slurring technique in which water is pumped down a 150-ft. drill hole to the phosphate veins and phosphate is washed up through an adjacent hole. Some 10 billion tons of phosphate would become available along the Pamlico River.

•
The U.S.'s first privately financed plutonium lab has been opened at Battelle Memorial Institute (Columbus, O.). Plutonium, now a by-product of uranium-fueled reactors, is considered the future fuel of choice.

•
Six low-cost flame retardants for plastics, based on a new type of chemical reaction, are being offered in development quantities by Monsanto Chemical Co. this week. They are organophosphorus compounds, trademarked Phosgard, made by use of three reactants: phosphorus chlorides or bromides, certain carbonyl-containing compounds, and esters of trivalent phosphorus acids. Suggested uses are in polystyrene, polyolefins, phenolics, acrylics, epoxies, polyesters, polyurethanes, paper, rayon, and possibly in synthetic fibers.

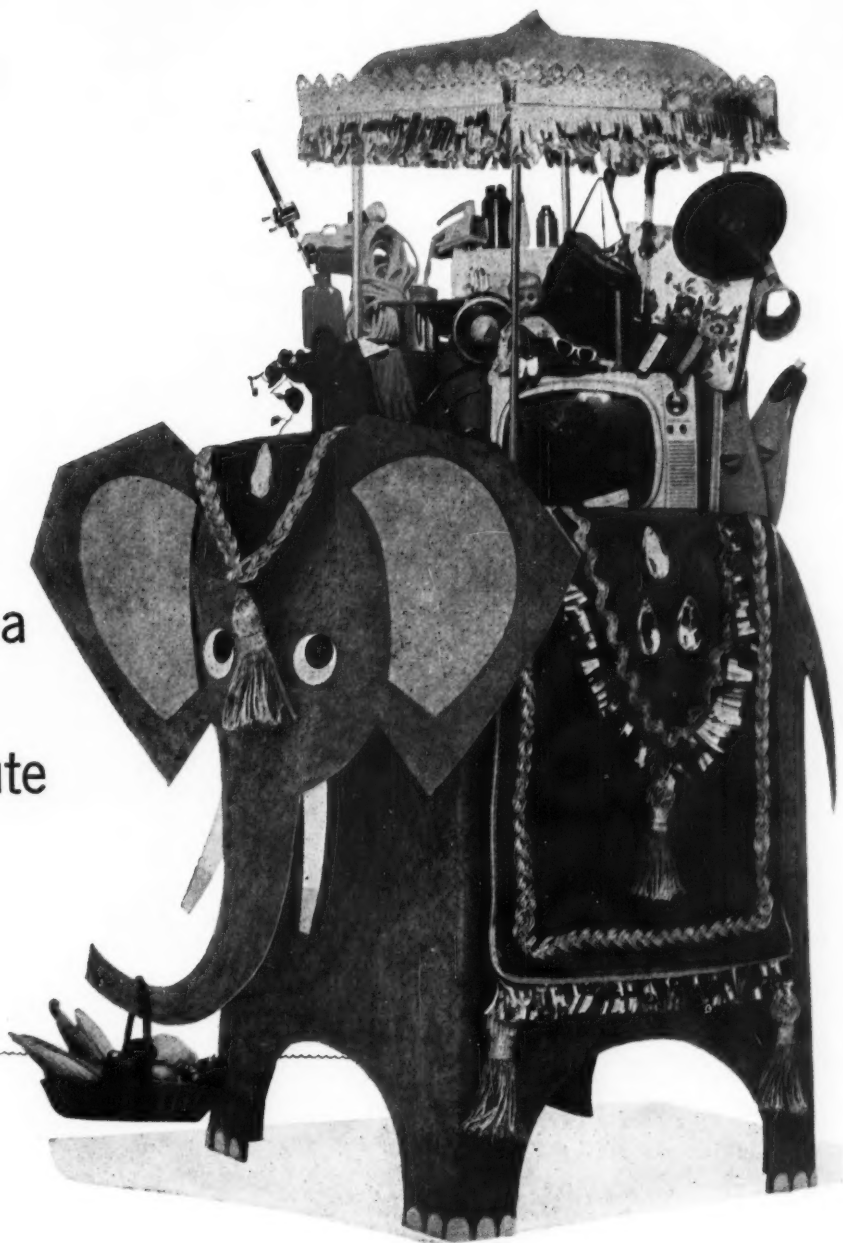
Process inventor: Gail Birum of Monsanto's Research and Engineering Division (Dayton, O.). His preferred reagents in each of the three classes are chlorides of trivalent phosphorus, aldehydes, and trialkyl phosphites. Birum says extensive variations in end-products are possible by changing the reactants, particularly the carbonyl compounds. In the reaction, the halogen atoms bonded to phosphorus are replaced by phosphinyl hydrocarbyloxy groups.

•
A process that bypasses the Bayer process to recover alumina from clays has been developed by researchers at the Division of Mineral Chemistry, C.S.I.R.O., in Melbourne, Australia. Although the method is being kept secret because of patent confusion, the Aussies say it has "slightly higher" investment costs but lower operating costs than the Bayer process. Hints are that it can handle clays inferior to the bauxite required for the Bayer process. If true, the process may be a competitor for the North American Coal-Strategic Materials process that recovers aluminum sulfate from waste clay by-products of coal mining (*CW*, June 18, p. 164).

•
First step in Texaco's new liquid propellants research for the Air Force will reportedly be a massive literature search. The \$1.3-million contract calls for a comprehensive study of liquid propellants, their handling and storage problems. Besides being the largest research contract in the field yet awarded by the Air Force, the agreement represents a much-sought-after plum among CPI firms. The contract is considered an "in" to producing possible new propellants.

According to L. C. Kemp Jr., vice-president in charge of Texaco's Research & Technical Dept., the firm's search for the "ideal" propellant will cover "exotic" liquid fuels, oxidizers and monopropellants.

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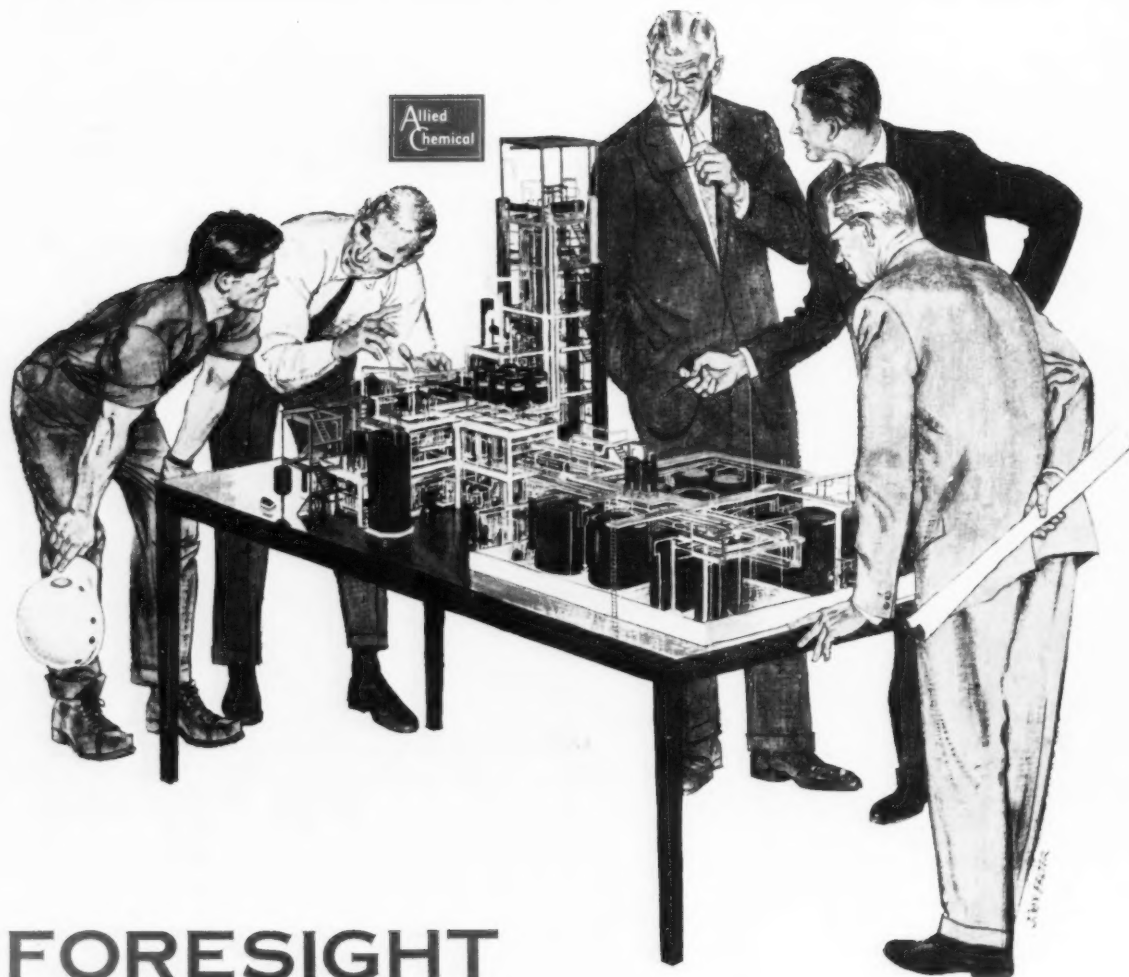
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CW PHOTO—WALTER VECCHIO

Informing firemen of new hazards in fighting chemical plant fires is important management duty.

Putting New Heat on Fire Fighting

The firemen pictured here are learning about one of their most unenviable possible jobs: fighting a chemical plant fire. And like many fire fighters — and chemical plant managers — they may soon be caught up in a controversy that seems certain to be fanned by materials and techniques now being introduced for use against chemical fires.

For example, new choices are coming up in dry-chemical extinguishing agents. Sodium bicarbonate, the major ingredient of dry-chemical agents for many years, will face a challenge from potassium bicarbonate (*CW Technology Newsletter*, Aug. 6) and a combination of monoammonium phosphate, barium and ammonium sulfate and urea-formaldehyde resin.

Other dry chemicals have been developed for special applications such as fighting metal alkyl (polyolefin catalyst) fires. Tests aimed at setting new standards for carbon dioxide extinguishing systems have recently been conducted by Factory Mutual Labo-

ratories. And rounding out the welter of new data for study: developments in fire-fighting foams, sprinkler systems and fire-detection equipment, and findings from recent fires.

Most fire protection experts agree with James Duggan — Union Carbide Chemicals' director of safety and fire protection — that any discussion of fire-extinguishing materials and techniques is difficult because of inevitable controversy. The problem: to make presentations without appearing critical of materials, equipment, techniques and the user's judgment.

Charles Anthony, chief chemist of Walter Kidde's Aerospace Division, puts fire protection into the same touchy category as first aid, where there is often disagreement.

Best Solutions: Chemical companies are faced with the problem of sifting available data, coming up with the best fire-protection system for their needs, then using their system to best advantage if a fire occurs.

Duggan, who is also president of

the Society of Fire Protection Engineers, points out that qualified fire protection engineers are not plentiful. They have had to fight hard for profession recognition. And accredited courses in universities are lacking.

Testing of materials, equipment and techniques is also a problem. Underwriters' Laboratories testing is usually required for insurance purposes. But tests can often serve only to set minimum requirements, keep marginal items out of use. Chemical plants, with their many special requirements, often call for more than UL-approved items. And using plant fire-fighting systems to best advantage calls for continual education and training of employees.

The small company that can't justify having its own fire company faces one of the toughest challenges. How one such firm, Kay-Fries Chemicals, solves the problem, works with the local fire company is shown on p. 92.

Purple K: Of the new choices on (Text continues on p. 94)

PRODUCTION



Drill starts with operator phoning alarm to firemen.

Plant's fire brigade fights 'fire' until firemen arrive.



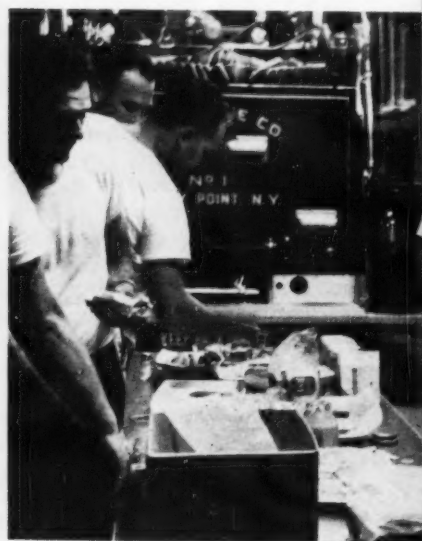
Work and Play

On a recent hot, humid evening Kay-Fries Chemicals held its annual joint fire drill with the local volunteer fire company, Wayne Hose Co. of Stony Point, N.Y.

For plant management, the drill served as a gauge of its fire protection efforts, which, like that of most



After stowing gear, firemen tour plant, see problem areas.



Back at fire house, sandwiches and



Firemen hook up hoses (above) while Winfield and Fire Chief Gerry Martin direct operations (right).

Weld Local Fire Fighters into Plant Safety Team

small plants, is complicated by lack of a fire company of its own. For the fire company, the drill gave its volunteers a chance to test equipment on the plant site, become acquainted with the plant's particular fire-fighting problems.

And after the drill was over, plant

and fire company personnel relaxed, cemented relationships over beer and sandwiches at the fire house.

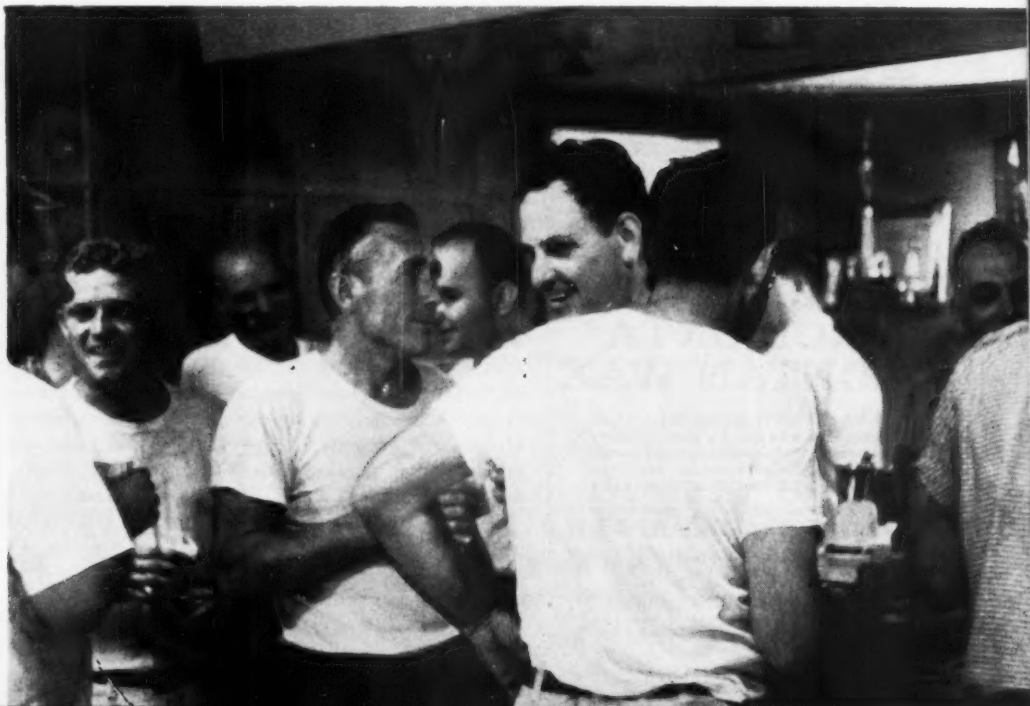
This year Plant Safety Director Holt Winfield threw the firemen a curve, picked a hard-to-get-to location for the site of the mock fire. The firemen were not flustered, raced to a fire

house in the next town to borrow a brand-new deck gun.

Winfield's one fear: complacency. Kay-Fries hasn't had a fire in nine years. But, if the Stony Point firemen's demonstration is any indication, complacency may be the least of his problems.



beer finish drill.



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PRODUCTION

the way for fighting fires with dry chemicals, potassium bicarbonate, supplied by Ansul Chemical Co. (Marinette, Wis.), Chemical Concentrates Division of Baker Industries (Ft. Washington, Pa.) and The Fyr-Fyter Co. (Dayton, O.), is already being used on Navy helicopters for dropping onto fires. It's called Purple K because of its color and glow it gives off on contact with fire, and has proved to be up to twice as efficient as sodium bicarbonate in some cases.

But the material has yet to receive Underwriters' Laboratories approval, isn't in commercial use. There seems to be little doubt that UL approval will be obtained. Widespread commercial use is a clouded issue, however.

There are reports that in tank-fire tests (commonly used for commercial testing), Purple K's advantage is narrow, or even nil. And, at a cost of about two-and-one-half times that of sodium bicarbonate, which is less than 20¢/lb., there is some doubt that there will be many commercial takers.

All-Purpose Extinguisher: The combination of monoammonium phosphate, barium and ammonium sulfate and other ingredients is promoted as an all-purpose dry-chemical extinguishing agent.

Ordinary bicarbonate dry-chemical agents are suitable only for Class B (oil, gasoline, paint, etc.) and Class C (electrical) fires. The monoammonium phosphate combination is also rated for Class A (wood, cloth, paper, etc.) fires, is called an ABC agent.

ABC dry chemicals have been used in Germany for several years, and Alim Corp. (New York) recently became the first to win UL approval for its ABC agent.

All of the major dry-chemical suppliers, such as American LaFrance (Elmira, N.Y.), Ansul, General Fire Equipment (Culver City, Calif.), Walter Kidde & Co. (Belleville, N.J.) and Chemical Concentrates, which mainly sells to other suppliers, are on the verge of receiving UL approval.

But reaction so far is only lukewarm. Some firms point out that to obtain the suitability for all classes of fires there will be some sacrifices in effectiveness in fighting some types of fires. And, reportedly, the cleanup problem after fighting electric-motor fires is difficult.

Some companies point out that it will still be best to work out a system

rather than depend on a universal ABC extinguishing agent. For example, water is usually best for extinguishing fires in buildings (Class A type). Carbon dioxide works well on electrical equipment fires (Class C).

For special fires, special dry chemicals have been developed. For example, metal alkyl (polyolefin catalyst) fires are now being fought with ordinary sodium bicarbonate to which a finely divided absorbent (e.g., silica gel) has been added. The bicarbonate kills the fire, the absorbent prevents reignition, according to Arthur Guise, Ansul's director of design and development.

Trimethoxyborane can be tricky, but effective, in fighting magnesium fires, according to Guise — although Ansul won't sell it on a guarantee basis. TMB is actually a flammable liquid. However, it puts a coating on the magnesium. The TMB catches fire, but then foam or water (which can't be used directly on the magnesium) can be used to put out the TMB fire.

Liquid metal fires, given importance by the use of liquid metal coolants in atomic energy applications, can often be fought with sodium chloride and graphite.

Although use of carbon tetrachloride is waning because of toxicity problems, fluorinated hydrocarbons are regarded with promise. Main stumbling block: cost. Monobromotrifluoromethane, for example, is priced at \$4-5/lb., which would keep it in the "special fire" class.

Water Often Best: Water has always been the basic fire-fighting chemical. And, although it can't be used for some fires (e.g. where it will react with the burning chemical), it will absorb more heat — and probably at a faster rate — than any other fire-fighting material. That's the key to its popularity, and much has been done to improve its heat absorption (e.g., spraying; the use of chemicals—e.g., Carbide's Unox—to reduce surface tension).

Some companies, such as Chemical Concentrates, are working on improved foam chemicals. Other major firms supplying foam include National Foam System (West Chester, Pa.), Rockwood Sprinkler (Worcester, Mass.) and Fyr-Fyter.

"Automatic" Sprinkler Corp. of America (Youngstown, O.) has de-



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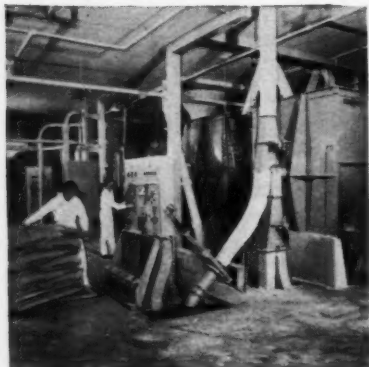
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CW/107

PRODUCTION

veloped a combination foam-water system, is one of the few companies set up to incorporate any type of fire-fighting equipment into a protection system.

An improved carbon-dioxide system should be along before another year is out, according to Robert Bowman, chief engineer of Walter Kidde's Industrial and Marine Division. This is the result of tests conducted for the leading carbon-dioxide system suppliers by Factory Mutual Laboratories. Aim: new standards to improve system reliability.

Detection First: Bowman's feeling is that, except in special cases, the materials now used in fire fighting are adequate. What is most needed is improved detection techniques. Speed of response is the key. But there is a dilemma: devices that are capable of better detection may react too quickly, sound an alarm when no dangerous condition has occurred.

Most systems operate on the temperature-rise principle, activate an alarm or equipment through the expansion of gas confined in a chamber. Of new systems that have been developed, Pyrotronics Division of Baker Industries (Newark, N.J.) offers a device with a radioactive source, operates on an ionization principle. Minneapolis-Honeywell has a safety eye that spots smoke or flame (CW, Nov. 15, '58, p. 56), but it has been applied to detecting burner flame-outs rather than budding fires.

For protecting equipment from fires, Walter Kidde has an overheat detector system that operates on the thermistor principle: a ceramic thermistor core encased in a protective Inconel tube is subject to a drop in resistance when heated; measurement of the change in electrical resistance gives an indirect measurement of temperature. The system is used to detect hot spots on the refractory lining of Texaco synthesis gas generators (CW, June 30, '56, p. 76), has not yet been promoted for other applications by Kidde.

Evacuation Important: Early detection is important, not only for quick action before the fire gets out of control but also for rapid evacuation of personnel.

New efforts to improve fire detection and extinguishment may cause controversy, but they're bound to help make plants safer places to work.

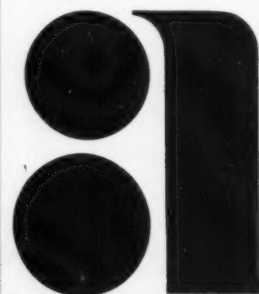
H.A. and D.M.B.



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PROPERTY DATA

Physical Properties Compound	H.A. para Methoxy Phenol	D.M.B. para Dimethoxy Benzene
Chemical Formula	$\text{CH}_3\text{OC}_6\text{H}_4\text{OH}$	$\text{C}_6\text{H}_4(\text{OCH}_3)_2$
Molecular Weight	124.13	138.16
Boiling Point °C		
760 mm. Hg.	243°	213°
100 mm. Hg.	175°	140°
50 mm. Hg.	160°	123°
10 mm. Hg.	126°	89°
Melting Point °C	53°	56°
Density gms./ml. (65°C)	1.1106	1.0293
Solubility (25°C in gms./100 gms. solvent)		
Water	4.1	Insoluble
Benzene	69.5	177.0
Acetone	426.0	233.0
Ethyl Acetate	245.0	150.0
Alcohol	456.0	33.3
Color	Tan to white	White
Odor	Characteristic	Sweet Clover



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Market Newsletter

CHEMICAL WEEK
September 17, 1960

More bromine capacity is coming onstream this week as Michigan Chemical starts up a new unit at El Dorado, Ark. With the expansion, output potential of the plant will be doubled from 5 million to 10 million lbs./year. The new unit is a joint venture with Murphy Corp. of El Dorado.

Transportation facilities are also being doubled, through the expansion of the joint venture's tank-car fleet, and extra storage facilities are being added to take care of customer peak-load or emergency requirements for bromine shipments.

Phenol prices are moving higher, as most producers follow the 1¢/lb. across-the-board price increase posted last week. The new tabs, by Monsanto, go into effect immediately for spot purchases; Oct. 1, for contract customers.

Most major producers contacted this week indicate they will go along with the new quotes. One uncommitted manufacturer, Dow, was still studying the situation, although it's probable Dow too will follow with a higher tab.

Reason: phenol demand is extremely brisk, boosting production to near capacity. It's reasonable to expect that soaring demand will encourage producers to start adding additional capacity during the next few months.

Isophthalic-rich aromatic acids are now being offered to a limited number of customers from Amoco's facilities at Joliet, Ill. The material is being evaluated in unsaturated polyesters, where it is reported to have some quality advantages over straight isophthalic. Amoco is also moving ahead with plans for commercial production of regular isophthalic acid for use in alkyd resins.

Chemical rail shipments are moving again over the giant Pennsylvania Railroad System. The 12-day tieup ended early this week after causing moderate disruption and delay of chemical shipments in the 13-state area served by the road.

Chemical shippers have started using the new chemical distribution terminal at Beverly, Mass., near Boston (*CW, July 9, p. 33*). First one: Antara Chemical Division of General Aniline & Film Corp. The cargo: a 100,000-gal. load of blended and dyed ethylene glycol antifreeze bound for New England markets.

Chemical marketers interested in applying motivational research to their own marketing problems can get an objective view of this field

Market Newsletter

(Continued)

from a just-completed study: "Uses of Motivational Research in Marketing," which was released by the National Industrial Conference Board last week.

The study, undertaken for NICB by Dr. L. C. Lockley, professor of business administration at the University of Santa Clara, sets forth factually and in layman's terms what motivational research is, what it can do, its strength and weaknesses, and how it can be integrated into the existing web of marketing research.

Main use of MR, the report finds, is in areas where there is emotional involvement—e.g., when consumers cannot give, or are reluctant to give reasons for their attitudes.

•
U.K. and German production of man-made fibers continues its rapid growth. During the first seven months of '60, U.K. output was 352 million lbs., an increase of 23% over the 285.6 million lbs. turned out during the same period in '59, according to the British Man-Made Fibers Federation. July's output was the highest for that month, totaling 46.7 million lbs., compared with 45.3 million lbs. in July '59.

In Germany, output of man-made fibers during the first half of the year is reported to have increased 42% over the corresponding period of last year. Germany ranks in fourth place among world synthetic fiber producers, after the U.S., Japan and Great Britain.

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Meanwhile sales of the German chemical industry are also up sharply, reaching the equivalent of \$2.7 billion during first-half '60, 17% more than the corresponding period of last year.

•
Some shifts in the synthetic rubber industry's concentration of production were evident in '59, according to the Justice Dept.'s "Fifth Report on Competition in the Synthetic Rubber Industry," released last week. Production share of the record 1.1 million tons of U.S. synthetic rubber output last year declined slightly (in proportion to total capacity) for Goodyear, Firestone and Goodrich-Gulf.

•
Changes in capacity ranking were also noted. Goodrich-Gulf moved ahead of Goodyear to top spot, while the biggest gains were made by Copolymer Rubber and Chemical Corp., which moved to fifth place ahead of Phillips and Shell. By Dec. 31, the report predicts, capacity of the five largest producers will break down as follows: Goodrich-Gulf, 272,500 long tons; Goodyear, 270,000; Firestone, 251,500; Texas-U.S., 156,000 and Copolymer, 133,000.

•
On the West Coast, which accounts for about 10% of total domestic sales, Shell's share of the market increased to 64.4%, slightly more than its 59.5% share in '58. General and Copolymer gained slightly in their share of the West Coast market, while Goodyear dropped substantially.

Eastman's custom processing service speeds marketing of new products for many companies

A number of producers of chemicals are now using Eastman's custom processing service to help shorten the time lag between development of new products and commercial scale manufacture. These companies point to several advantages that result from going outside their own organization to carry out certain organic chemical reactions. They avoid tying up capital in costly special-purpose or infrequently used equipment. They speed commercial production of new chemicals by eliminating process development and engineering design

steps. They can use the custom processing service as additional production facilities when their own equipment is working at capacity. And they can take advantage of Eastman's specialized equipment and experience in handling certain unstable or hazardous reactants. Contracts can be drawn up for either one-time jobs or continuing, planned processing. If any of the reactions described here interest you, write for specific information, quantities and scheduling. Your inquiry will receive prompt attention.

Aromatic Reactions

Reductive Alkylation—of aromatic mono- or di-amines by condensing with ketones to form Schiff bases which are then reduced to the N-alkylated or N,N'-dialkylated aromatic amines. Aromatic nitro compounds are generally satisfactory as starting materials since they are reduced to amines under the reaction conditions.

Amination—of aromatic phenols (mono- or polyhydroxy) with aniline or other primary amines to give N-alkylated amines; for example, hydroquinone reacted with aniline gives 4-hydroxydiphenylamine.

Etherification of Phenols—with alkyl sulfates or halides to give mono- or polyethers, including compounds such as monomethyl, dimethyl, diethyl, dipropyl and dibutyl ethers of hydroquinone.

Reactions of Anthraquinone Derivatives—as for example the reaction of quinizarin (1,4-dihydroxyanthraquinone) with primary alkyl or aryl amines to give 1,4-bis(substituted amino)-anthraquinone.

Alkylation of Phenols—with alkenes or alcohols to give alkyl phenols including such compounds as 2,6-ditertiary-butyl-p-cresol, mono- or ditertiarybutyl hydroquinone, and mono- or ditertiaryoctyl hydroquinone.

The Fries Rearrangement—of esters of phenols to give compounds such as 2,5-dihydroxyacetophenone.

Nitration—of phenolic ethers, anilides and other aromatic compounds to give nitration in various positions. For example, the dimethyl ether of hydroquinone reacted with nitric acid gives the dimethyl ether of nitrohydroquinone.

Nitrosation—of amines or phenols to give nitroso compounds, as for example the reaction of dimethylaniline and nitrous acid to give p-nitrosodimethylaniline.

Custom Processing Department
Chemicals Division

Eastman
CHEMICAL PRODUCTS, INC.
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KINGSPORT, TENNESSEE

Aliphatic Reactions

Acetylations—of alcohols or amines with acetic acid, acetic anhydride or ketene to give such compounds as esters, amides and anilides. Acetic anhydride and ketene are particularly useful with heat-sensitive compounds.

Aldol Type Condensations—with aldehydes, ketones, or both, to produce such compounds as acetaldol, butyraldol and 2,2-bis(hydroxymethyl)butyraldehyde (trimethylolpropane intermediate).

Anhydride Formation—of symmetrical or mixed anhydrides by reaction of acetic anhydride with various organic acids.

Dehydrations—of aldols and ketols catalytically or thermally to give such compounds as crotonaldehyde and isobutyridene acetone.

Dehydrogenations—of primary or secondary alcohols in liquid or vapor phase reactions to give, as examples: acetaldehyde, propionaldehyde, acetone, methyl ethyl ketone, and methyl hexyl ketone.

Esterifications—of saturated and unsaturated monohydric or polyhydric alcohols and monobasic or polybasic acids.

Hydrogenations—up to 2000 p.s.i.g. and 250°C. with various catalysts. Partial, selective hydrogenations of unsaturated aldehydes to saturated aldehydes such as 2-ethylhexenal to 2-ethylhexanal, and crotonaldehyde to butyraldehyde, have been carried out, along with experimental work on reducing the aldehyde group without hydrogenating the double bond, to give such compounds as allyl and crotyl alcohols. Complete reductions of aldehydes and unsaturated compounds have also been carried out to make butyl alcohol, 2-ethylhexanol, and isocaproic acid. Hydrogenations are also valuable in up-grading materials with undesirable unsaturation or color.

Oxidations—of saturated and unsaturated aldehydes, alcohols and aromatic compounds catalytically with air to give acids containing no inorganic products other than catalysts. Examples are the preparation of acetic, butyric, 2-ethylhexanoic, crotonic, benzoic, toluic and phthalic acids.

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tennessee; Atlanta; Boston; Buffalo; Chicago; Cincinnati; Cleveland; Detroit; Greensboro, North Carolina; Houston; Kansas City, Missouri; New York City; Philadelphia; St. Louis.
West Coast: Wilson & Geo. Meyer & Company, San Francisco; Los Angeles; Portland; Salt Lake City; Seattle.

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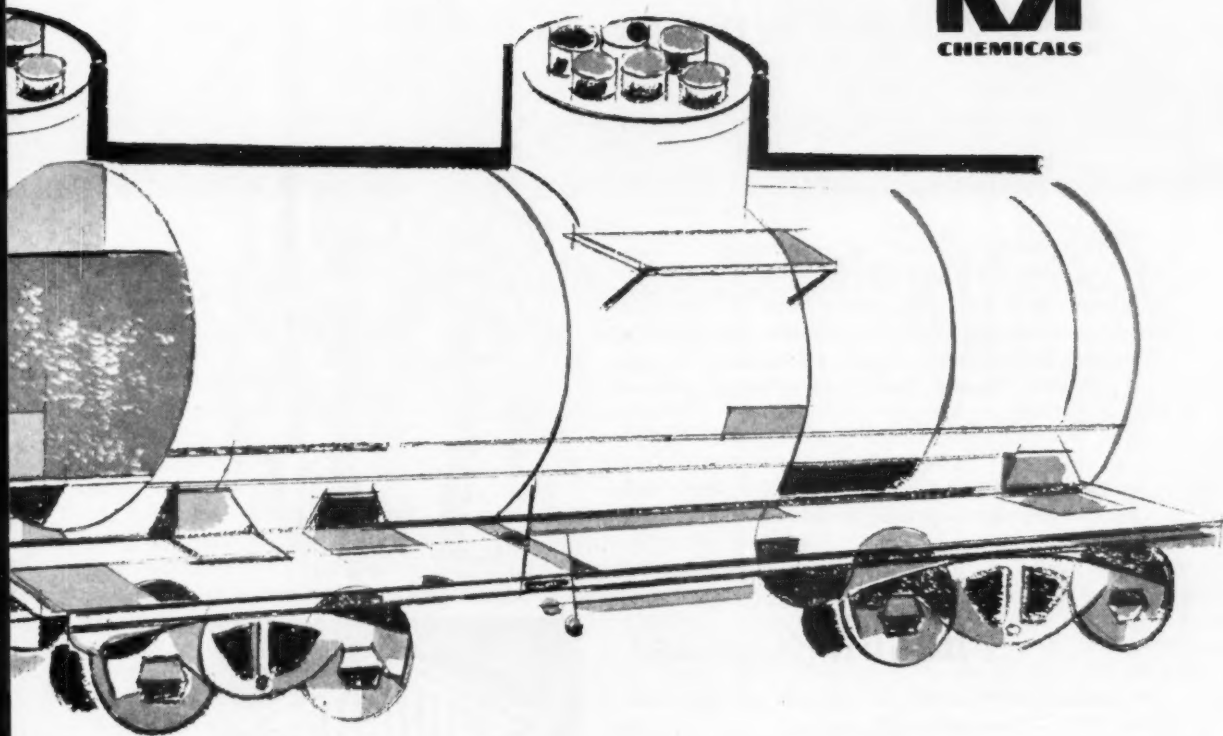
To help the chemical industry keep pace with our expanding economy and growing population, Olin Mathieson is on the move. Currently we are increasing caustic/chlorine

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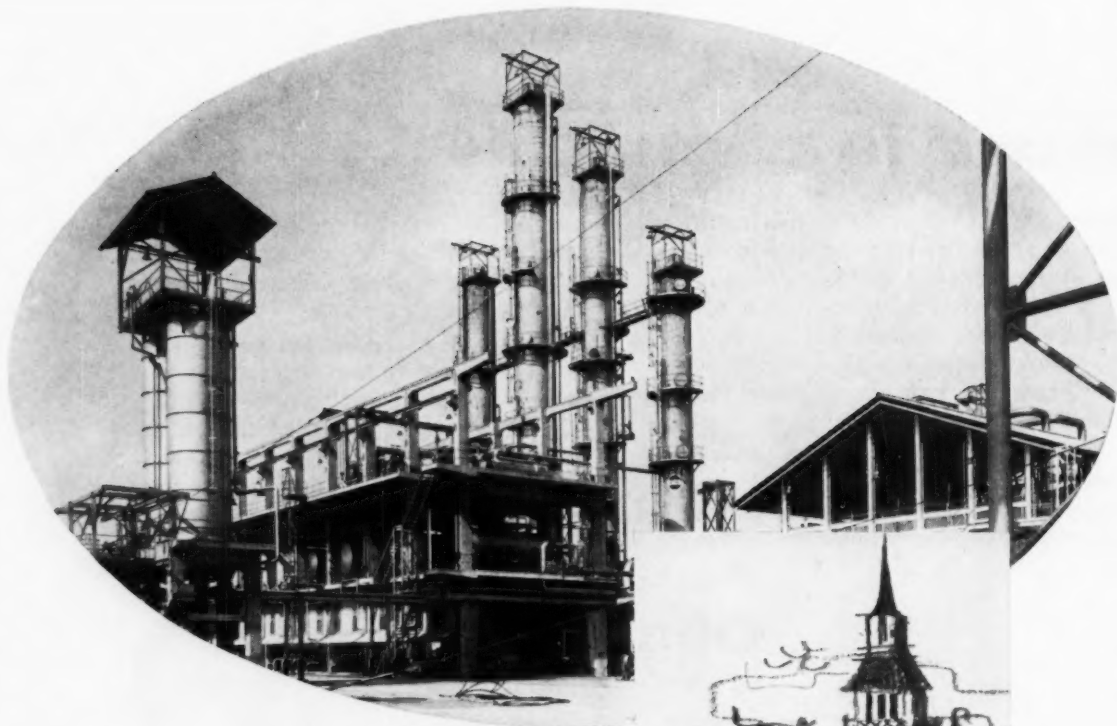
Change is the challenge, and the future depends on the ability to predict change and prepare for it. As a step in providing for your future, let us review your chemical requirements now. In terms of future — or present — developments, our experience in chemical supply can be useful.

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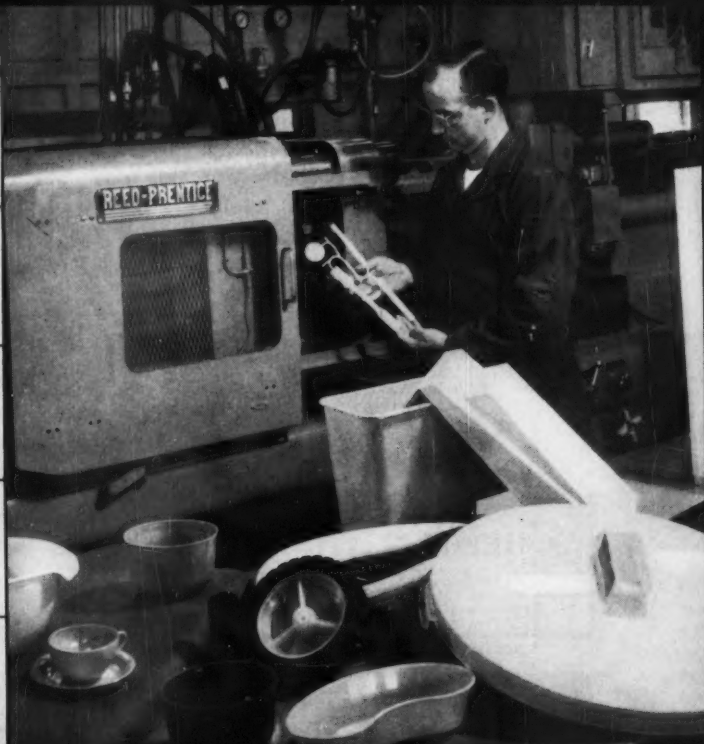
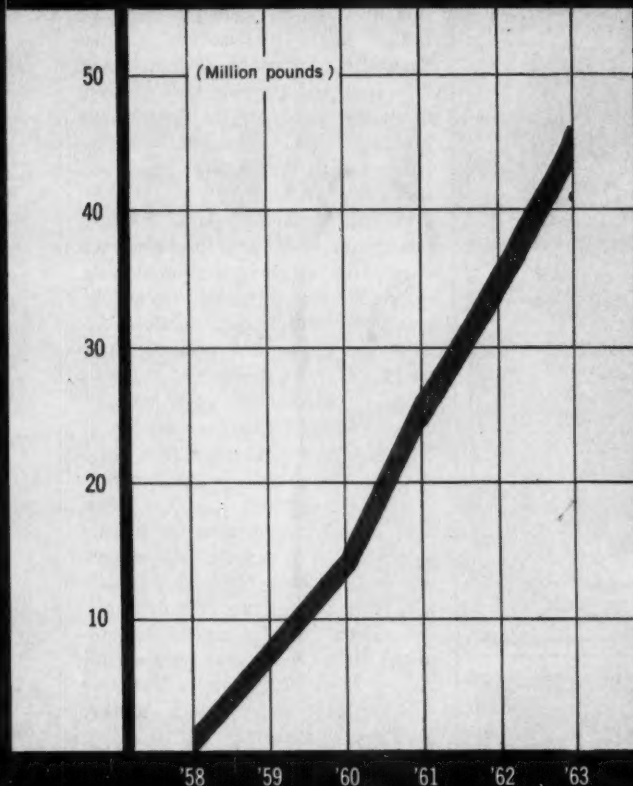
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WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM,
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Injection molding: fast-rising polypropylene market



Injection molding spawns variety of polypropylene products

Polypropylene Bids for Molding Market

In a little over two years polypropylene resins have managed to grab the bottom rung of the 800-million-lbs./year thermoplastic injection-molding ladder and at the same time establish a position in the plastic film and fiber businesses. Total usage this year is expected to be in the 20-23-million-lbs./year range, with molders taking slightly over half of this. And producers have high hopes that their powerful promotional campaign will result in an even more impressive record.

Typical of the new efforts is Spencer Chemical's "seminars" for molders; the first of four begins this week in Chicago.

These meetings are intended to spur the growth pace in the field that is already most encouraging for poly-

propylene makers—molding, which will consume about 11-13 million lbs. of resin this year. In '59, first full year of polypropylene commercial production, molding took about 8-9 million lbs. of material.

Spencer's other seminars this month, in Cleveland, Boston and New York, will concern the chemistry, processing conditions, design of equipment and molds for polypropylene. As a result, says Spencer's senior market analyst, J. M. Jordan, polypropylene can win a 45-million-lbs./year market in injection molding in the next three years.

While the number of products that can be injection molded with polypropylene are diverse, three major categories (housewares, automotive and appliance industries) stand out in

roughly that order of importance to polypropylene resin makers.

Housewares Highest: The \$3-billion/year housewares industry is the prime target for new resins. In '59 half of the polypropylene resin consumed in injection molding (4.5 million lbs.) went into housewares. This year that market will almost double, to about 7-8 million lbs.

Future growth will come harder, however. Polypropylene will be bucking the two giants in the business, styrene and polyethylene. About 10% of styrene-type molding resins, and 65-70% of polyethylene molding resins go into houseware items. And it appears now that linear polyethylene will be the hottest competitor.

Some of the products of polypropylene were exhibited at the National





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MARKETS

Housewares Manufacturers Assn. exposition in Atlantic City, N.J., last July. Several coffee makers shown had molded-polypropylene lid, handle and base as well as the coffee basket inside the pot. Some major manufacturers of Thermos-type bottles showed polypropylene-clad jugs, with lids, cups and stoppers molded from the resin. Tri-State Plastic Molding Co. exhibited its extensive and colorful line of polypropylene dinnerware, tumblers and bowls.

Another potentially large outlet is squeeze mops. O'Cedar displayed such a mop; its entire squeezing housing, including hinge, is molded from polypropylene. The product retails at \$2-2.50 and carries a five-year guarantee.

Such extensive uses of polypropylene would help hike consumption of the resin to around 15 million lbs./year by '63 in housewares alone.

Automotive Push: The auto industry, another growth area for plastics in general, is a target of polypropylene in particular. Although the auto industry's current use of polypropylene molded resins is almost nil, producers feel they can soon sell a sizable volume here—at first by substituting polypropylene for plastics already used by the industry.

Cellulosics are expected to be vulnerable, particularly on a price basis. Typical parts made from cellulosics include steering wheels, arm rests, brake handles, knobs and buttons.

Polypropylene's lower price is also expected to be of some advantage in competition with nylon. But this is not expected to add significantly to polypropylene poundage. Although 60-70 parts on an average car are made of nylon, the total amount used is less than 1 lb./car.

Other resins used in autos—impact and copolymer styrenes and linear polyethylene—are also expected to get serious competition from polypropylenes.

But a large part of polypropylene growth in the auto industry will come as designers and builders find ways to use the plastic instead of metals. In '56 the average car was using about 11 lbs. of plastics. Last year this figure had grown to 20 lbs./car, and is expected to be about 35 lbs./car by '63.

Polypropylene makers are counting on these promising areas of growth



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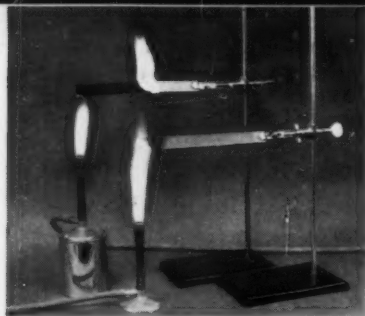
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TCBP-A can be used to produce new resins with built-in fire protection. Resin formulators find that flame-retardant resins create new markets for myriad uses in bonding, foaming, casting, coating, and fabrication of structural laminates. The TCBP-A structure in the resin adds fire resistance to chemical resistance. As an example, flame-retardant epoxies (self-extinguishing by ASTM Test) can make "fire break" coatings for industrial plants and fire-resistant electrical panels; the polyesters can make fire-resistant building panels. In addition to fire resistance, most resins made with TCBP-A have excellent flexural and compressive strength and high temperature stability. For example, polycarbonates made with TCBP-A show outstanding strength at high temperatures ... plus greatly increased toughness.



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Depending upon the degree of flexibility desired, the amount of Santicizer 8 in the formulation may range from 5 to 20 parts of the emulsion. For more dependable bonding of tough-to-join surfaces, try Santicizer 8 in your PVAc emulsion adhesives.



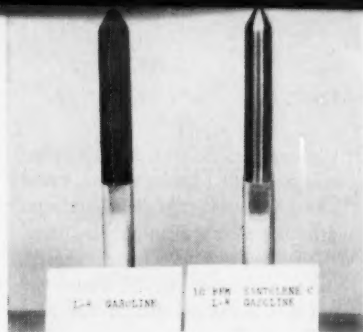
PARA-TOLUENESULFONAMIDE... gives lower-cost mildew protection to paints

Protecting water-base paints against fungi-souring in the can is good insurance for a brand's shelf life. And, protecting the applied oil-base and water-base films against the formation of discoloring fungus stains and "blotches"—no matter how severe the humidity exposure—is a distinct selling benefit. Such anti-mildew paints are particularly needed for white house paints used in the South. PTSA offers its protection against mildew formation to coating and impregnating varnishes, house paints, masonry paints and interior decorative finishes. Added as part of the solids in a range of 2 to 8%, PTSA prevents the growth of mold and mildew even under the high temperature and humidity of the tropics. PTSA blends readily into paint, varnish, and lacquer formulations. The free-flowing white powder does not interfere with pigmentation, is non-irritating and cuts the cost of formulating a mildew-resistant paint by approximately 50% compared to earlier anti-fungal additives.

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SANTICIZER® 160...protects nitrocellulose lacquers from rancid odors and possible "spewing"

Why have many lacquer makers replaced castor oil in nitrocellulose formulations? Answer: Santicizer 160 plasticizer... for these reasons:

1. Castor oil has a low compatibility with nitrocellulose. To obtain needed lacquer properties, formulators sometimes exceed the compatibility limit. Consequently, exudation or "spewing" occurs. Partial or complete replacement of castor oil with Santicizer 160 helps eliminate the compatibility problem to prevent "spewing."
2. Castor oil may and often does give off a rancid odor. With chemically made Santicizer 160... no odor whatever.
3. The lacquer formulator often must adjust castor oil viscosity to improve water resistance. Frequently this affects the film color. With Santicizer 160, no viscosity adjustment is necessary.
4. Santicizer 160 is dependable in price and supply; does not fluctuate in cost and availability as do natural materials.

For these four good reasons, more and more lacquer makers are protecting their nitrocellulose lacquer quality and performance by formulating with Santicizer 160.



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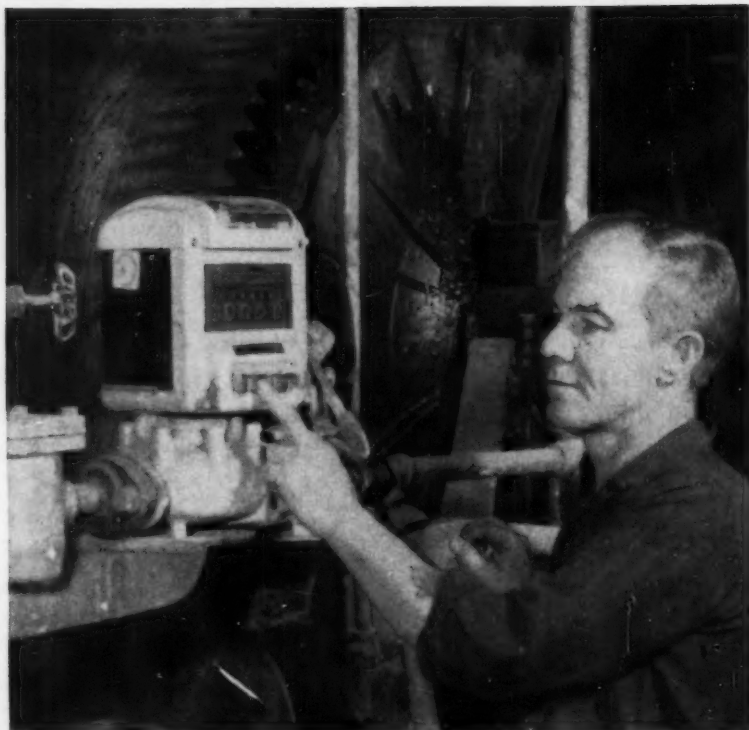
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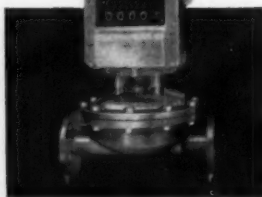
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MARKETS

in replacing metals: with blow-molded sun visors, molded brake pedals, radio grills and instrument panel housings. Polypropylene usage might increase to 2 lbs./car by '63. A market of 7 million cars/year would mean an outlet for 14 million lbs. of the resins.

Appliance Science: Appliances, large and small, are another fruitful field for plastics. The styrenes—impact, heat-resistant and copolymer types—currently take the lion's share. But polypropylene has fared exceptionally well during its brief time in this market, and practically every major appliance manufacturer uses polypropylene in one way or another. The molded parts do their best jobs where relatively high operational temperatures are encountered.

This year polypropylene consumption in appliances is expected to be around 3-4 million lbs. vs. approximately 2 million lbs. in '59.

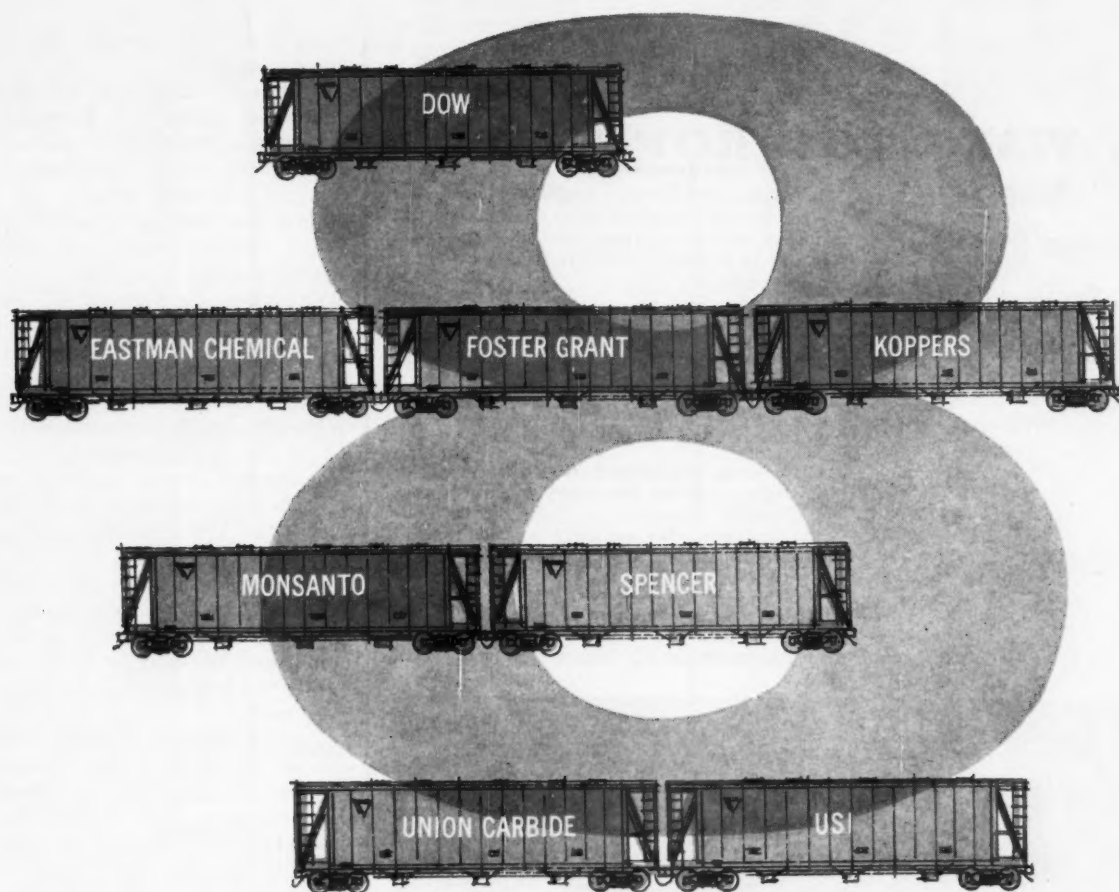
On Call: Another potential application for polypropylene is in manufacture of telephone handsets. This has been a rapidly changing market for plastics. Phenolics, which were first used, were supplanted by cellulose butyrates and, in recent years, by cellulose propionate. Now both ABS (acrylonitrile-butadiene-styrene) and polypropylene are being evaluated. At stake: a market estimated at 7-8 million lbs./year.

Still another big potential, the 30-million-lbs./year plastic closure market is now dominated by thermosetting resins, primarily urea and phenolics. Styrene and polyethylene are the major thermoplastics used. But since the thermosetting closures are compression molded, a major equipment change will be needed in some cases for thermoplastics to gain larger volume.

Nevertheless, polypropylene is a promising closure material, and consumption of the resin in this end-use will be around 1 million lbs. in '60 and might double by '63.

Many other, miscellaneous outlets for polypropylene are also being pursued—thermoplastic pipe fittings, for example. Total market here is about 2 million lbs./year of various plastics, with styrene, ABS polymers, vinyls and nylon used principally.

Several firms are already making fittings, valves and similar items from polypropylene, and polypropylene



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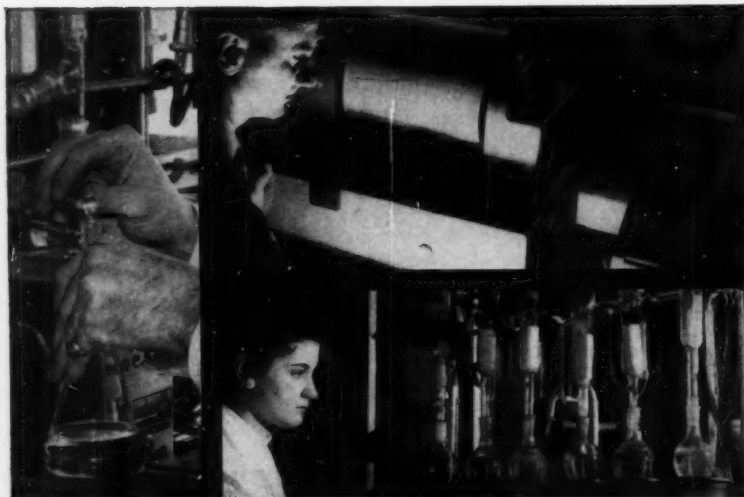
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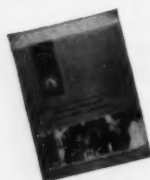
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MARKETS

might be able to take about 50% of this market by '63.

Other applications that will consume small quantities of polypropylene include hospitalware, personal items (combs, brush backs, mirrors, etc.) and laboratory ware.

More than Molding: Second to injection molding, the major end-use of polypropylene is in fibers, mostly in monofilament production. (Recently, Reeves Brothers, Inc., started commercial production of polypropylene bristles for brushes.) Total polypropylene monofilament fiber demand in '60 will probably be about 7 million lbs. If the textile market opens to polypropylene, its usage could become of such large volume it would far outstrip projected injection-molding demand for the resin.

Third-largest outlet for polypropylene is in film. It's a new market—about 2-3 million lbs./year of the resin is used here—but by '63, it may well be the largest end-use for polypropylene.

Capacity increases by the growing number of producers has stiffened polypropylene competition, heightened the pressure to open new markets. Promotional seminars like those sponsored by Spencer are a response to this situation, an attempt to bolster a young contender's prospects in a rugged market contest.

'OldWorld'EconomyUp

Industrial output in most European countries has expanded far more rapidly during the past six years than output in Canada or the U.S., the National Industrial Conference Board reports.

NICB particularly notes the rapid increase of production in France, West Germany, Belgium, Luxembourg, the Netherlands and Italy; '59 output of the six, as a group, averaged 157% of the '53 level, while U.S. production was only 112% of the '53 level.

The widespread capital boom in Europe was still evident in early '60, with the volume of capital goods output increasing at a much faster rate than the over-all volume of gross national product. Regarding the U.S., the modest rise in the volume of capital goods expenditures in the U.S. may be due in part to temporary overcapacity in some sectors of the national economy, NICB says.

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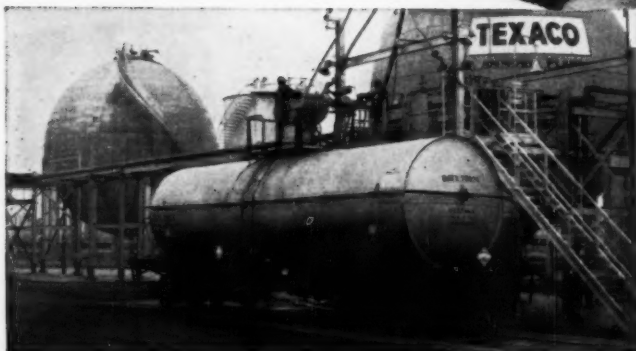
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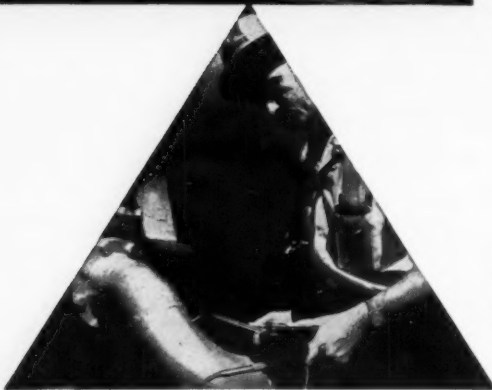
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Slash pine, prime source of southern pulp, moves up conveyor at Buckeye Cellulose's plant in Florida.

Pulpwood Pulls Papermakers to the South

In the 10-state* area of the South that stretches from Texas eastward to Florida, and northward to Virginia and Tennessee, the pulp and paper industry is expanding at breakneck pace. Fast-growing papermaking capacity is swelling chemical markets, giving new impetus to the paper industry's chemical suppliers.

And the sharply rising curve for Southern pulp and paper expansion shows no signs of leveling off. Among plants coming onstream, or planned:

- Catawba, S. C.—Bowaters Carolina Corp. will expand its plant to add a paper machine for making printing papers.

- Brunswick, Ga.—Brunswick Pulp & Paper Co. is planning a \$35-million expansion to add its first paper machine.

- Augusta, Ga. — the Deerfield

* Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Texas, Virginia.

Glassine Co. has located the South's first glassine mill near Continental Can Co.'s plant at Augusta. Scheduled to go onstream next spring, the plant will get its slush pulp from Continental.

- Monroe, La.—An indication of expected growth in the industry is Olin Mathieson Chemical Corp.'s decision last fortnight to spend \$13 million on a chlorine and caustic soda plant at Charleston, Tenn., scheduled to go onstream late in '61.

- Counce, Tenn. — Tennessee River Pulp & Paper Co. has a \$30-million pulp and paper mill now under construction.

- A half-dozen other projects elsewhere are building or in the planning stages now (See p. 41).

A measure of Southern papermaking capacity comes from figures put together last week by the Atlanta field office of the U. S. Dept. of

Commerce, which show that the South (including Maryland, Delaware and West Virginia) produced 40% of U. S. paper and paperboard in '59, with about three-fourths of its total of 13,672,701 tons coming from Alabama, Florida, Georgia, the Carolinas, Virginia and Louisiana.

Southern paper production has risen 66% in the past 10 years, compared with a rise of 12% in the Northeast and 18% in the North Central region. The West has shown a booming 94% gain.

The '59 production figure was about 1.5 million tons greater than that of '58 with all of the principal producing states sharing in the gains.

Largest Southern producer was Florida, which stood second in the nation with 1,955,561 tons, exceeded only by Wisconsin's 2,181,752. Georgia was fourth with 1,784,945, behind New York's 1,892,553. A list of the

10 largest pulp-and-paper producing states in the U.S. includes six other Southern states: South Carolina, Louisiana, Alabama, Tennessee, North Carolina and Mississippi.

Why the Rush: Key reason cited by papermakers for the rush southward is simple. In the northern U. S., and Canada, they say, it takes 80 to 100 years to grow a pulpwood-size conifer. In the Southeast, the same weight of pulpwood takes only 15 to 20 years. This short growth cycle works with improved forestry techniques to offer a tremendous supply of quality pulpwood at costs that allow Southern producers to stay competitive in the U.S. and world markets.

And there seems to be plenty more pulpwood. Figures compiled by the Southern Pulpwood Conservation Assn. indicate that in the South as a whole, the paper companies control only 20 million of the total 193 million acres of forest land.

Usually the big companies own land in ratio to the length of time they've been in the region. For example, Union Bag-Camp, which has had its big mill—the world's largest—in Savannah for several decades, owns considerable land in Georgia and South Carolina. On the other hand, Bowater, which has been in the Carolinas a very short time, holds almost no woodland acreage in comparison with the old-timers.

Papermakers agree that, at present, the Southeast coastal area has about as many papermills as its pulpwood resources can economically supply. But there is still plenty of acreage in the inland areas of Louisiana, Arkansas and Texas.

Other Developments: Papermakers list two important developments that have fostered locations in the South. First is the technology that has made possible the use of hardwoods. For years hardwoods were considered a forest nuisance. Now, improved technology allows their use, entirely or in part, for making fine-quality papers.

A second factor influencing Southern industry growth is the use of wood chips. In years past lumber sawmills in the South burned the huge quantities of chips they accrued from barking, stripping, cutting operations. Now, because of improved pulping methods, these chips can be bought and transported to pulpmills at savings

Dixie's Bustling Papermills

LOCATION	NAME	TYPE PLANT	CAPACITY
ALABAMA			
Brewton	Container Corp. of America	Bleached kraft,board and pulp	600,000 lbs./day
Coosa Pines	Coosa River Newsprint Co.	Kraft pulp and newsprint	160,000 lbs./day
		Semibleached kraft	48,000 lbs./day
		Fully bleached kraft	18,000 lbs./day
		Groundwood	120,000 lbs./day
		Kraft and newsprint	160,000 lbs./day
Demopolis	Gulf States Paper Corp.	Kraft, pine and hardwood	800,000 lbs./day
Tuscaloosa	Gulf States Paper Corp.	Lo-Thermo pine and hardwood	800,000 lbs./day
		Kraft and bleached bag, pine and hardwood	800,000 lbs./day
Mobile	International Paper Co., Southern Kraft Division	Bleached and unbleached sulfate fiber	1,015 tons/day
Naheola	Marathon Southern Corp.	Unbleached and semibleached, bleached kraft, newsprint	1,205 tons/day
		Bleached kraft	630,000 lbs./day
		Paper and tissue	360,000 lbs./day
Anniston	National Gypsum Co.	Gypsum board liner paper	350,000 lbs./day
Mobile	National Gypsum Co.	Ground wood and semichemical	600,000 lbs./day
Mobile	Scott Paper Co., Southern Division	Fiber insulation board	850,000 lbs./day
		Kraft	796,000 lbs./day
Mobile	Stone Container Corp.	Tissue	400,000 lbs./day
		Patent coated, board, kraft	180,000 lbs./day
FLORIDA			
Pensacola	Armstrong Cork Co.	Insulation board	—
Foley	Buckeye Cellulose Corp.	Bleached sulfate, dissolving sulfate	200,000 tons/year
Fernandina Beach	Container Corp. of America	Kraft	1,200,000 lbs./day
Hollywood	Hawthorne Paper Co.	Towel, wrapping, specialties	30,000 lbs./day
Palatka	Hudson Pulp & Paper Corp.	Unbleached pulp, kraft	1,700,000 lbs./day
		Finished kraft	950,000 lbs./day
		Bleached pulp	400,000 lbs./day
		Tissue	160,000 lbs./day
Panama City	International Paper Co., Southern Kraft Division	Unbleached sulfate fiber	1,620 tons/day
		Kraft board	1,515 tons/day
Miami	Miami Paper Board Mills, Inc.	Boxboard, patent coated, bleached Manila	150,000 lbs./day
Miami	National Felt & Paper Corp.	Felt	70,000 lbs./day
Jacksonville	Owens-Illinois Glass Co., Mill Division	Unbleached sulfate	1,000,000 lbs./day
Fernandina Beach	Rayonier, Inc.	Kraft	900,000 lbs./day
		Chemical cellulose	700,000 lbs./day
Port St. Joe	St. Joe Paper Co.	Unbleached sulfate	2,400,000 lbs./day
Jacksonville	St. Regis Paper Co.	Unbleached sulfate	3,000,000 lbs./day
Pensacola	St. Regis Paper Co.	Kraft	2,600,000 lbs./day
		Bleached, unbleached sulfate	1,500,000 lbs./day
Jacksonville	Volney Felt Mills, Inc.	Kraft	1,460,000 lbs./day
		Felt	120,000 lbs./day
GEORGIA			
Macon	Armstrong Cork Co.	—	—
Austell	Austell Box Board Corp.	Board mill	225,000 lbs./day
Brunswick	Brunswick Pulp & Paper Co.	Bleached sulfate	920,000 lbs./day
Savannah	Certain-teed Products Corp.	Felt	120,000 lbs./day
Augusta	Continental Can Co.	(Mill under construction)	—
Macon	Georgia Kraft Co.	Sulfate	1,350,000 lbs./day
Cedartown	Noble Manufacturing Co.	Boxboard	60,000 lbs./day
Valdosta	Owens-Illinois Glass Co., Mill Division	Kraft	1,200,000 lbs./day
Jesup	Rayonier, Inc.	Chemical cellulose	100,000 tons/year
Rome	Rome Kraft Co.	Sulfate	1,450,000 lbs./day
Savannah	Ruberoid Co.	Felt	160,000 lbs./day
St. Marys	St. Marys Kraft Corp.	Bleached, unbleached sulfate	1,600,000 lbs./day
Boiton	Sonoco Products Corp.	Semichemicals	280,000 lbs./day
Port Wentworth	Southern Paperboard Corp.	Sulfate	600 tons/day
Savannah	Union Bag-Camp Paper Corp.	Unbleached sulfate, neutral sulfite, semichemicals	4,100,000 lbs./day
LOUISIANA			
Shreveport	Bird and Son	Rag and felt	300,000 lbs./day
Elizabeth	Calcasieu Paper Co., Inc.	Unbleached kraft	480,000 lbs./day
		Kraft	480,000 lbs./day
Marrero	Celotex Corp.	Bagasse	1,800,000 lbs./day
Hodge	Continental Can Co., Inc., Containerboard & Kraft Paper Division	Kraft pulp	1,160,000 lbs./day
		Kraft paper	1,100,000 lbs./day



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to sawmills and pulpers alike. In '59, 2.5 million cords of chips were bought for pulping operations.

Chemical Needs: For chemical companies, Southern papermills offer vast opportunities for locating chemical plants that will economically serve the regional markets.

According to a CHEMICAL WEEK roundup of papermill managers' expectations, biggest needs in the immediate future will be for bleaching materials, especially sodium chloride, caustic, and sodium chlorate. Reason for this is a trend in the bleached-board industry—especially packaging—toward whiter and brighter papers.

But management reports other needs, too, mainly coatings, sizes and fillers. They report that there are frequently short supplies of rosin sizing materials, because of the increasing demands for them in the fast-growing bleach-board segment of the industry, which uses four or five times as much size as liner-board plants, for example. Plant managers say this is upsetting the balance between supplies of tall oil and demand for rosin size.


The present problem of rosin-size supply is twofold. First, there is a general shortage of crude tall oil, because a basic source of this is the paper industry itself, and the industry is using it faster than it produces it. Second, the supply of stumps used in wood-distilling rosin is shortening. This is because the stumps have to stay in the ground for 10 to 15 years if they're to yield good gum. But now, in order to cut costs and get timberland back into production, woodsmen pull the stumps as they cut the timber. So, this is a diminishing supply area for the gum source.

For coatings and fillers, management reports, kaolin, taken from rich deposits in Georgia, is finding growing favor. Plants with paper machines are boosting demand, which will eventually make full use of the Georgia deposits.

Another material that is in critical supply from time to time is salt cake—sodium sulfate—often termed by papermakers as "unfeasible" for them to make themselves. At present, German-imported supplies occupy a significant niche in the market, although recovery from waste pulping liquor is another source.

Location Factors: Papermakers list

Dixie's Bustling Papermills			
LOCATION	NAME	TYPE PLANT	CAPACITY
New Orleans	Flintkote Co.	Rag, felt	135 tons/day
		Sulfate	2,080,000 lbs./day
Bogalusa	Gaylord Container Corp.	Semichemicals	270,000 lbs./day
		Semichemical pulp	590 tons/day
Bastrop	International Paper Co., Southern Kraft Division, Bastrop Mill	Semichemical corrugating	550 tons/day
		Bleached sulfate	570 tons/day
Bastrop	International Paper Co., Southern Kraft Division, Louisiana Mill	Groundwood	25 tons/day
		Bleached kraft	560 tons/day
Springhill	International Paper Co., Southern Kraft Division	Bleached, unbleached sulfate	1,420 tons/day
		Kraft	1,300 tons/day
New Orleans	National Gypsum Co.	Asbestos	—
		Semichemicals, soft hardwood	300,000 lbs./day
Baton Rouge	Norallyn Paper Mills, Inc.	Newsprint	500,000 lbs./day
West Monroe	Olin Mathieson Chemical Corp.	Kraft	—
St. Francisville	St. Francisville Paper Co. Valentine Pulp & Paper Co.	Coated paper	(Now starting up)
		Bagasse	200,000 lbs./day
Lockport		Fine paper	150,000 lbs./day
MISSISSIPPI			
Meridian	Flintkote Co.	Wood fiber board insulating materials	—
Moss Point	International Paper Co., Southern Kraft Division	Bleached sulfate	650 tons/day
		Semibleached, bleached kraft	595 tons/day
Natchez	International Paper Co., Southern Kraft Division	Bleached sulfate, dissolving	900 tons/day
Natchez	Johns-Manville Products Corp.	Insulating and hardboard	700,000 lbs./day
		Unbleached kraft pulp	100 tons/day
Lumberton	Lumberton Pulp Co.	Insulating and hardboard	550,000 sq. ft./day
Greenville	U.S. Gypsum Co.	Groundwood	360,000 lbs./day
		Felt	122,000 lbs./day
Meridian	Web-Cote Roofing Co.		
NORTH CAROLINA			
Charlotte	Carolina Paper Board Corp. Carolina Paper Mills, Inc. Champion Paper & Fibre Co.	Board mill	150,000 lbs./day
		Tissue	38,000 lbs./day
		Bleached sulfate	1,860,000 lbs./day
		Bleached semichemicals	100,000 lbs./day
Patterson	Doll Paper Co. Ecusta Paper Division, Olin Mathieson Chemical Corp.	Paper	1,550,000 lbs./day
		Board	450,000 lbs./day
		Crepe cellulose	8,000 lbs./day
		Fine paper specialties, converted paper and paper products	—
Pisgah Forest	Halifax Paper Co.	Sulfate	1,300 lbs./day
		Kraft	1,150,000 lbs./day
Roanoke Rapids	Manchester Board and Paper Co.	Chip	120,000 lbs./day
Sylva	Mead Corp., Sylva Division	Semichemical chestnut fiber	450,000 lbs./day
		Corrugating	450,000 lbs./day
Plymouth	North Carolina Pulp Co.	Bleached, unbleached sulfate	2,250,000 lbs./day
		Semichemicals	650,000 lbs./day
Acme	Riegel Paper Corp.	Board	2,600,000 lbs./day
		Sulfate and semichemicals	350 tons/day
		Bleached sulfate	350 tons/day
		Bleached board	250 tons/day
Morehead City	Volney Felt Mills, Inc.	Felt	100,000 lbs./day
SOUTH CAROLINA			
Catawba	Bowaters Board Co.	Hardboard	500,000 sq. ft./day
Catawba	Bowaters Carolina Corp.	Unbleached, semibleached sulfate	800,000 lbs./day
Georgetown	International Paper Co., Southern Kraft Division	Unbleached sulfate	1,455 tons/day
		Semichemical pulp	535 tons/day
Hartsville	Sonoco Products Co.	Kraft and corrugating	1,860 tons/day
		Semichemicals	280,000 lbs./day
Charleston	West Virginia Pulp & Paper Co.	Board	750,000 lbs./day
		Unbleached sulfate pulp	2,700,000 lbs./day
		Linerboard and unbleached paper	2,400,000 lbs./day
TENNESSEE			
Calhoun	Bowaters Southern Paper Corp.	Cold soda	350,000 lbs./day
		Sulfate	900,000 lbs./day
		Groundwood	1,500,000 lbs./day
		Newsprint	2,450,000 lbs./day
Memphis	Buckeye Cellulose Corp.	Dissolving, specialty grades	100,000 tons/year
Chattanooga	Container Corp. of America	Board	200,000 lbs./day
Memphis	Kimberly-Clark Corp.	—	—



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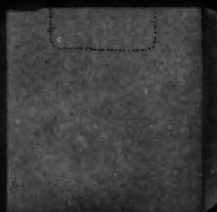
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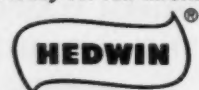
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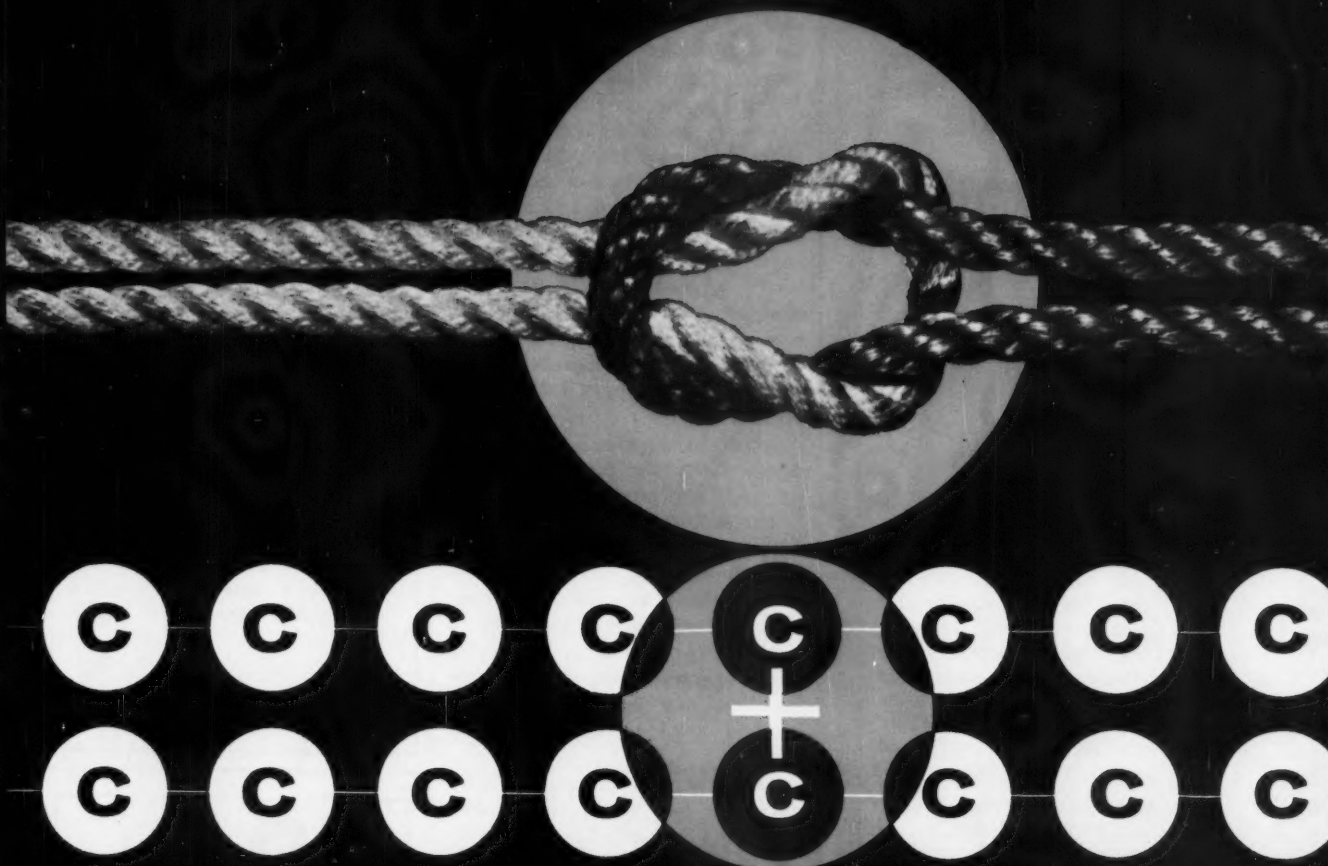


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ADMINISTRATION

Dixie's Bustling Papermills

LOCATION	NAME	TYPE PLANT	CAPACITY
Memphis	The Lehon Co.	Felt	100,000 lbs./day
Harriman	Mead Corp., Harriman Division	Semichemicals	225,000 lbs./day
Kingsport	Mead Corp.	Chestnut Soda	250,000 lbs./day 480,000 lbs./day
Chattanooga	Southern Chemical Cotton Co.	Book and bond Chemical cotton (bulk)	720,000 lbs./day 250,000 lbs./day
Knoxville	Southern Extract Co.	(sheeted) Semichemicals	250,000 lbs./day 210,000 lbs./day
Chattanooga Counce	Tennessee Paper Mills Tennessee River Pulp & Paper Co.	Chestnut board Board	210,000 lbs./day 590,000 lbs./day
Memphis	Volney Felt Mills, Inc.	Unbleached kraft Felt	500 tons/day 100,000 lbs./day
TEXAS			
San Antonio	Barrett Division, Allied Chemical Corp.	Felt, building paper	80,000 lbs./day
Pasadena	Champion Paper & Fibre Co.	Bleached sulfate Paper	1,200,000 lbs./day 950,000 lbs./day
Evadale	East Texas Pulp & Paper Co.	Groundwood Bleached	100,000 lbs./day 1,200,000 lbs./day
Dallas	Fleming & Sons, Inc.	Bleached kraft	830,000 lbs./day
Sherman	Lime Material Industries	Bleached kraft board and paper	760,000 lbs./day
Rotan	National Gypsum Co.	All grades paper	600,000 lbs./day
Orange	Orange Pulp & Paper Mills, Inc.	Fiber pipe and conduit Board	7,000 lbs./day 725,000 sq. ft./day
Dallas	The Ruberoid Co.	Wrapping and kraft	140,000 lbs./day
Ft. Worth	Southern Johns-Manville Products Corp.	Rag, felt	60 tons/day
Diball	Southern Pine Lumber Co.	Felt	—
Lufkin	Southland Paper Mills, Inc.	Fiber insulating board products	100,000,000 sq. ft./year
El Paso	Tempron Corp.	Groundwood Sulfate	1,700,000 lbs./day 600,000 lbs./day
Galena Park	U.S. Gypsum Co.	Newsprint	1,800,000 lbs./day
Houston	Volney Felt Mills, Inc.	Bleached	600,000 lbs./day
Irving	Volney Felt Mills, Inc.	Hardboard and insulation board	(To be constructed)
VIRGINIA			
Richmond	The Albemarle Paper Mfg. Co., Brown's Island Plant	Paper	270,000 lbs./day
Richmond	The Albemarle Paper Mfg. Co., Hollywood Plant	Felt	120,000 lbs./day
Buena Vista	Bonded Fibres, Inc.	Felt	160,000 lbs./day
West Point	The Chesapeake Corp. of Va.	Absorbent Latex saturated specialties	50,000 lbs./day 50,000 lbs./day
Hopewell	Continental Can Co., Inc., Containerboard & Kraft Paper Division	Kraft, unbleached sulfate	1,350,000 lbs./day 1,100,000 lbs./day
Hopewell	Hercules Powder Co.	Paper	1,350,000 lbs./day
Columbia	James River Pulp Corp.	Unbleached sulfate	1,400,000 lbs./day
Richmond	Manchester Board & Paper Co., Inc., Seaboard Mill	Kraft, semichemicals	1,900,000 lbs./day
Richmond	Manchester Board & Paper Co., Inc., Southern Mill	Sheeted and loose chemical cotton pulp	750,000 lbs./day
Lynchburg	Mead Corp., Heald Division	Groundwood	50,000 lbs./day
Big Island	Owens-Illinois Glass Co., Mill Division	Boxboard	300,000 lbs./day
Jarratt	Southern Johns-Manville Products Corp.	Chip and news	160,000 lbs./day
Richmond	Standard Paper Mfg. Co.	Semichemicals	350,000 lbs./day
Franklin	Union Bag-Camp Paper Corp.	Board	400,000 lbs./day
Covington	West Virginia Pulp & Paper Co.	Pulp Building board	550,000 sq. ft./day
		Absorbent board	—
		Pulp	1,200,000 lbs./day
		Sulfate	1,200,000 lbs./day
		Kraft	1,200,000 lbs./day
		Bleached sulfate	1,160,000 lbs./day
		Unbleached sulfate	160,000 lbs./day
		Semichemicals	540,000 lbs./day
		Kraft, corrugating, coated and uncoated bleached boards	1,650,000 lbs./day 20,000 lbs./day
		Board	



DI-CUP . . . *The Chemical Way to Cross-Link Polyethylene*

Di-cup, Hercules dicumyl peroxide, is a source of free radicals, which are highly effective in chemical cross-linking. It provides a simple, economical, and practical means of cross-linking low-density polyethylene.

Cross-linked polyethylene is a thermoset material resistant to softening and deformation at high temperatures. It shows no evidence of environmental stress cracking and it is resistant to many solvents at high temperatures.

This development opens new markets for products that require superior toughness, flexibility, impact strength, and chemical resistance.

For more information on Di-cup, write

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Naval Stores Department

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NO60-2



The facilities and staff of Gamma Chemical Corporation are geared for the custom production of most synthetic organic chemicals. We have successfully produced for others such diverse products as tranquilizing drugs and rubber intermediates.

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ADMINISTRATION

a number of criteria they apply to selecting sites for papermills. These are equally useful to chemical producers in figuring likely spots to build chemical supply operations.

Tops in importance, of course, is pulpwood supply. Hardwoods can be shipped a maximum of 40 to 50 miles by truck and 100 to 150 miles by rail. Says one manufacturer, "Obviously you need to locate where there's a good supply, and where there aren't so many mills that you'll have to pay a price premium. You do best near two railroads so you can get the benefits of freight competition."

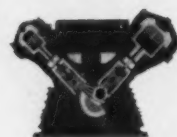
Second in importance is water, for transportation, for handling of effluent, and for process requirements.

Although for board mills, proximity to markets is important, most management finds that general location in relation to population centers has a strong bearing. They like to locate away from large cities that might aggravate air-pollution problems, but near enough to a small-but-nice town to keep employees happy.

Also, they point out, location should be where fuel and power sources won't be a problem. Least consideration of all, they say, is labor supply—"hardly a problem in relation to the other considerations."

Outlook: A glance at the locations of existing pulp and paper operations (see pp. 116, 118, 120) shows that the industry has settled fairly uniformly through the coastal belts of the South. Now, say papermakers, chemical management can expect more and more growth toward inland forested regions—mostly in Louisiana, Arkansas, Texas, and northerly portions of Georgia and Alabama—where there are adequate water supplies. They predict that further expansion at the coasts will be of existing plants; although improved "timber mining" techniques will double the pulpwood supply in those areas in the next 20 years, such supplies will be quickly grabbed up by operations that are now located there.

Development of finer bleached boards and coated papers is proceeding briskly, as is the refinement of various specialty papers. Kraft production is expected to grow at about the same rate as population and gross national product.



ANSWER to Worthington Hidden Value Puzzle

The fictitious "hidden value" on page 86 is, of course, the "Articulated Connecting Rod." This design is found only on light duty compressors with single acting cylinders.

The true Worthington connecting rod construction is shown above. Each rod is directly mounted on the main crankshaft, giving greatest bearing area and stronger linkage. There are fewer parts in all, maintenance is simpler and lubrication is less complex. Worthington Corporation.

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water-soluble
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Witco Chemical Co., Canada, Ltd.
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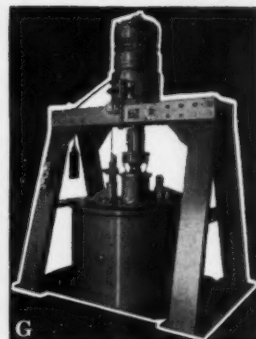
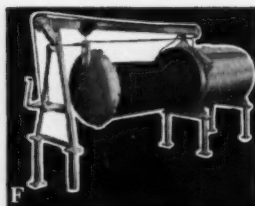
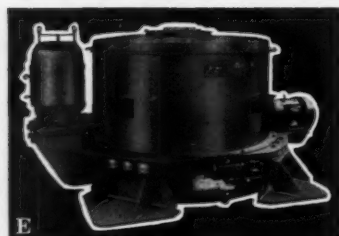
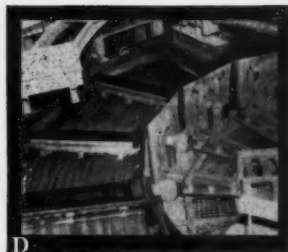
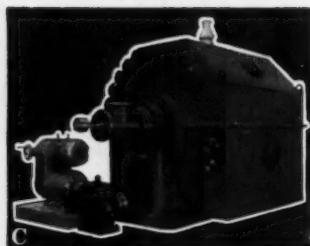
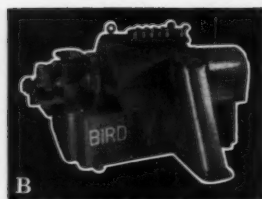
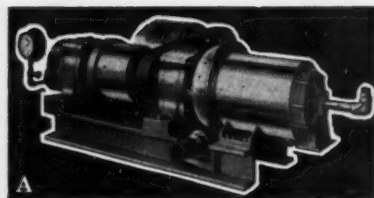
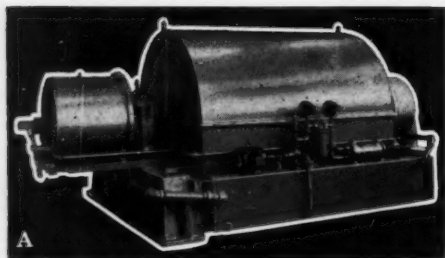
Reduce mar characteristics of corrugated board with PANAREZ Resin

The non-mar qualities of corrugated board used for furniture packing are substantially improved by treating the board with a special blend containing PANAREZ Resin. Tests demonstrate the mar-resistant superiority of this blend over straight wax or wax-polyethylene blends.

PANAREZ Resins are a series of five thermoplastic hydrocarbon resins derived from petroleum. PANAREZ 12-210 is the recommended resin for this application. Write for additional information about the use of PANAREZ Resin in corrugated board coating or ask your Amoco Chemicals representative. Your inquiry will receive prompt attention.

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(A) Bird Continuous Solid Bowl Centrifugals are clean, closed, compact, rugged and dependable. Shown are the smallest (6" bowl dia.) and the largest (54" bowl dia.). They come in sizes and designs to meet a wide range of deliquoring applications.

(B) Bird Continuous Screen Type Centrifugals deliver dry, clean crystals or granules from feed slurries high in solids content; efficient wash, often with less than 0.1 lb. wash liquor per lb. of solids.

(C) Bird-Young Rotary Drum Vacuum Filters provide extraordinary capacity per foot of filter area, efficient wash, wash liquor separation and fume-tight operation when desired.

(D) Bird-Prayon Tilting Pan Rotary Vacuum Filters assure long sustained operation, maximum wash efficiency, counter-current when desired, with complete separation of liquors, constant high output and minimum maintenance. Filter area ranges from 27 to 516 sq. ft.

(E) Bird-Humboldt Oscillating Screen Centrifuges dewater plus 65 mesh solids with almost no degradation or loss of solids. Output up to 80 tons or more per hour. Screens last thousands of hours. Power cost is only 0.2 KWA per ton of dried solids.

(F) Bird Pressure Leaf Filters offer large filter area, high rate of flow, working pressures up to 75 psi standard (250 psi special). Sturdily constructed of corrosion resistant alloys or with special linings; insulated; steam jacketed; in a wide range of sizes.

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Some Research-Oriented Company Periodicals

Publication Title	Company	Typical Article
Acrylo-News	American Cyanamid	"Dicyanoethylation of 9-Aminofluorene" (Abstract)
Advanced Materials Technology	The Carborundum Co.	"Fused Magnesium Oxide Refractories"
The Analyzer	Beckman Instruments	"High Resolution Infrared Spectroscopy"
The Bell System Technical Journal	American Telephone and Telegraph Co.	"The Charge and Potential Distributions at the Zinc Oxide Electrode"
Bell Laboratories Record	Bell Telephone Laboratories	"High Purity Nickel"
The Bulletin of the Dow Corning Center for Aid to Medical Research	Dow Corning	"Silastic Patch Prosthesis"
CIC Newsletter	Connecticut Instrument Corp.	"Tips on Micro Sampling"
Endeavour	Imperial Chemical Industries Ltd.	"Phosphonitrilic Derivatives"
Food and Drug Research	Food and Drug Research Laboratories	"Detoxification Mechanisms" (Book review)
Magnesium	Brooks & Perkins Inc.	"Finish Systems for Magnesium"
Monthly Abstract Bulletin from the Kodak Research Laboratories	Eastman Kodak	"Gelatin Hardeners" (Abstract)
Norelco Reporter	Philips Electronics and Pharmaceutical Industries Corp.	"A New Type of Crystalline Cellulose"
Petroleum Refining Developments	Ethyl Corp.	"Development of a Temperature- Stable Rocket Fuel" (Abstract)
Radio-Frequency Spectroscopy	Varian Associates	"Improved EPR Techniques for Free Radical Detection in Photochemistry"
Research Laboratory Bulletin	General Electric	"Improved Solid Lubricant"
Reynolds Aluminum Digest	Reynolds Metals	"The Resistance of Pure Aluminium to Corrosion by High Temperature Water" (Abstract)
Resin Review	Rohm & Haas	"A New Dimension in Ion Exchange"

Company Journals: New Research Voice

An increasing number of company publications, like those listed in the table, are stressing research in their editorial content. In addition to gaining prestige for their sponsors, such periodicals are a means of getting research data rapidly into wide circulation.

Jefferson Chemical, for example, is

currently considering publication of a research-oriented house organ. Philips Chemical recently started sending a research-type newsletter to its injection-molding plastics customers. And Union Carbide Chemicals is thinking of publishing an internal journal for papers by its research staff.

New awareness: One reason for the growth of company research publications is new awareness by editors that house organs can't carry both general subjects (e.g., personnel changes) and technological subjects and still have maximum effectiveness. An International Council of Industrial Editors survey in '56 disclosed in-

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Why Snell? Good question. Some of our clients have chosen us for our 40 years of professional experience; some for our million-dollar facilities; some for our experienced staff of 124; some for the fact that Snell services require no fixed overhead; you pay for what you use, not a penny more! Half of our projects are billed out at less than \$1,000. Best reason of all... but why don't you get in touch with us and find your own reason to use Snell services?

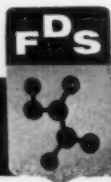
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RESEARCH

creasing interest in firmer editorial objectives. The survey chairman, General Electric communications specialist Henry Bacharach, feels this interest among editors is growing.

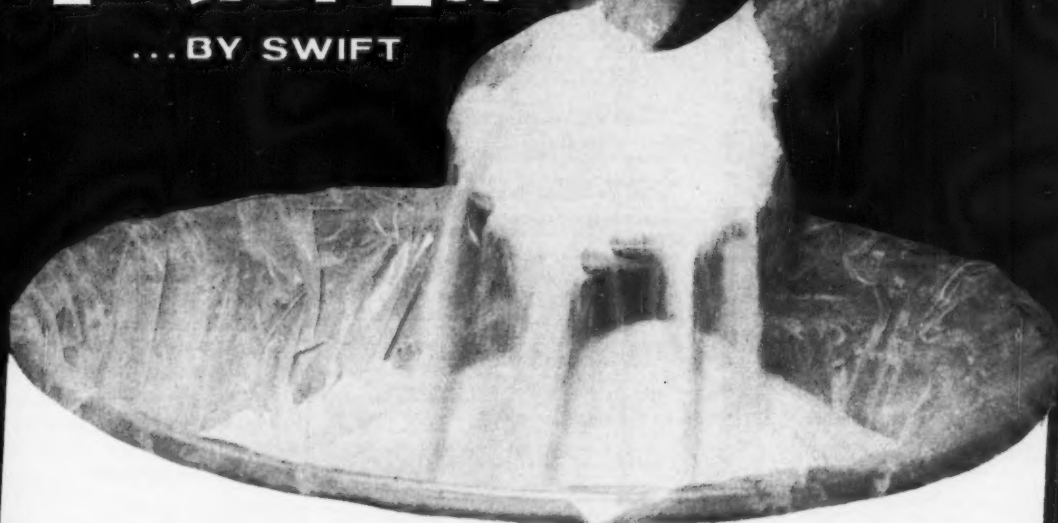
"Information that just isn't available anywhere else" is frequently published in Rohm & Haas's "Resin Review," "Amber Hi-Lites" and "Or-Chem Topics," according to the firm's advertising manager, Robert Goodale. He explains that the articles are often developed from research projects in Rohm & Haas laboratories. These articles also "get into print in a hurry," says Goodale. (Six months to a year may elapse before an article is accepted and appears in, for example, the "Journal of the American Chemical Society.") Moreover, they may identify key reagents by proprietary name—a practice frowned on in professional journals.

Production costs of "Resin Review," excluding the time of company personnel who work on its contents, come to about \$4,000 an issue (four times a year), includes about 15,000 copies per issue.

One of the best known organs of its type, "U.S.I. Chemical News," is budgeted at a little over \$200,000/-year, including both advertising space and direct mailing costs. Put out by U.S. Industrial Chemicals, the "News" is mailed to 14,500 recipients as a folder with advertising, also appears as a paid advertisement in business and trade magazines. New technology concerning the firm's products (ethyl alcohol, organic solvents and intermediates, sodium, etc.) is frequently featured. But information about products or processes in which USI has no proprietary interest also appears regularly. Its format has been emulated by other firms, including Dow, American Cyanamid ("Life on the Chemical News Front"), Pfadler, Wyandotte.

American Cyanamid's "Acrylo News" consists largely of abstracts of articles and patents related to acrylonitrile. "Acrylo News" reaches 3,000-5,000 subscribers (free) at a printing and distribution cost of \$750-800. Additional cost, such as screening of material to be abstracted, is shouldered by the library and other departments. Designed to create a product image—the chemical versatility of acrylonitrile—the publication also serves to enhance Cyanamid's

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SODIUM STEARATE
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Swift's Sodium Stearate is a new water soluble Metallic Complex. It is a consistently fine, highly uniform powder that is low in moisture and offers exceptional heat resistant properties.

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FLEXICHEM is Swift's trade name for a family of commercially pure complexes made possible by a new simplified reaction process. The benefit of Swift's development experience in utilizing stearate salts is available to serve you. Write for details.

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Type of salt:	Mono
Physical form:	Uniform powder
Fineness:	100% through 20 mesh
Color:	White
Odor:	Bland
Bulk density:	27 lbs. per cu. ft.
Melting point:	240 C. (Determined by Gradient Bar)
Iodine number:	2 maximum
Moisture:	4.1%
Free fatty acid:	1.0%
Total ash:	16.5%
Solubility:	Soluble in water and hot alcohol. Insoluble in esters and ketones, benzene, toluene, Zylene, Carbon Tetrachloride, vegetable and mineral oils.

For further details, ask for Bulletin 43.



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 Your Industry Better*

105th YEAR S-55R

CHEMICAL WEEK • ADVERTISERS' INDEX

September 17, 1960

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R. J. Claussen, 520 N. Michigan Ave.,
MOhawk 4-5800

Cleveland 13 H. J. Sweger, Duncan C.
Stephens, 1164 Illuminating Bldg., 55
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Grant, The Vaughan Bldg., 1712 Com-
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Denver 2 J. Patten, 1740 Broadway,
ALPine 5-2981

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St. Louis 8 R. J. Claussen, 2615
Olive St., CONTinental Bldg., JEFFerson
5-4867

*For complete product data see catalog unit in the BUYERS' GUIDE ISSUE for 1959-60

RESEARCH

reputation as a repository of information on the compound.

Naturally, no matter how profound the technical publication may be, it is designed to reflect favorably on the sponsor, although sometimes this approach is soft pedaled. "Petroleum Refining Developments," prepared by the Information Services Group of Ethyl Corp.'s Research and Development Dept., goes to appropriate executives with this title-page admonition: "... the contents do not necessarily reflect the opinions of Ethyl Corp."

Few company publications reflect the altruism of "Endeavour," elaborate quarterly review published in five languages and four colors by Imperial Chemical Industries Ltd. Its stated purpose: "to provide scientists, especially those overseas, with news of the progress of the sciences."

Most company periodicals are free. But The Ciba Foundation (London) charges for its books on medical and chemical research (e.g., "Biosynthesis of Terpenes and Sterols") to help offset costs. The monthly "Bell Laboratories Record" costs \$2/year.

Objectives and methods of editing the research journals vary in detail. "General Motors Engineering Journal," for example, frequently publishes papers that have first appeared in journals of the American Chemical Society, American Physical Society, or other societies. Associate Editor Thomas Macan says the book is aimed primarily at the engineering educator.

The Other View: But while all firms that now publish research-oriented publications agree the periodicals are useful as promotion tools, not all of these firms plan to expand their present programs of research publications, or agree that the device is spreading. Among these: Stanford Research Institute, publisher of "Research Newsletter"; Standard Oil of California (internal publications only); Crown Zellerbach (occasional research newsletter); Shell Chemical (monthly agricultural chemical bulletin); and Varian Associates.

Nonetheless, more than \$500 million is now spent on an estimated 9,000 industrial publications in the U.S. and Canada. The research type of publication, many observers believe, will be taking a bigger share of this outlay in the future.

Tracers

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POSITIONS VACANT

Operating Manager Wanted. Evaporated salt plant in south wants experienced superintendent to manage operation. Work record required to show ability to manage plant and handle people. Opportunity for right person. P-5215, Chemical Week.

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Armour Agricultural Chemical Company Needs Engineers. Mechanical Engineer: Experience in material handling conveyors, elevators, pumps or experience on steel layout, erection and construction. Chemical Engineer: No experience necessary. Will be trained in chemical control of triple superphosphate plant. Long range development to management. Chemical Engineer: Experience in chemical laboratory, fertilizer or phosphoric acid production desirable. Will be trained through sulfuric acid, phosphoric acid and triple superphosphate production for plant production management. Chemical Engineer: Five years fluoride experience in pilot plant development work. Chemist: Experience in chemical laboratory in fertilizer or triple superphosphate field. Salary commensurate with experience. Fringe benefits include hospitalization, vacation, sick leave and retirement. Position openings are in Florida and need date is October 1, 1960. Send reply to J.K. Sims Personnel Manager, Box 1685, Atlanta, Georgia.

Distributor Wanted—Texas and Southwest. For new dry chemicals to the swimming pool industry. Box 75054, Los Angeles 5, California.

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Successful Sales Organization Available For Exporters to Benelux. Here's rare opportunity for someone seeking a distribution set-up in the Benelux area. For 12 years, with great success, our firm has represented one of the largest U.S. producers of plastic materials. Only because they are setting up their own organization, we will lose one of our major products. We are seeking new plastic and chemical lines. Excellent references. Offices in Brussels and Rotterdam. Write: Imexin S.A., 5, av. de Broqueville, 15 Brussels, Belgium.

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Advertising—Marketing Manager seeks more challenging opportunity with chemical or chemical specialty manufacturer. Now handling complete advertising and promotional activities with a nationally-known chemical company. PW-3218, Chemical Week.

POSITIONS WANTED

Chemical Sales: 7 yrs exp. Selling Industrial & Detergent Chemicals, Surfactants, Emulsifiers, cutting oils, dye/pigment, resin & lacquer coatings. Prefer N.Y. - N.J. area. PW-5288, Chemical Week.

Ph.D. Twenty years organic synthesis, development, specialties, p.l.mers, waxes, detergents, sanitizers. Want laboratory direction plus, or participation. PW-5243, Chemical Week.

AUCTION

Former Kaiser Permanente \$18,000,000.00 Magnesium Plant, Manteca, Cal., 6 mi. from Stockton. Mon., Tues. & Wed., Set. 26-27-28, at 10 a.m. each day. Piece by piece. Furnaces, Mills, Conveyors, Vacuum Pumps, Retorts, \$500,000.00 New Supplies. Send for free circular now. Max Rouse & Sons, Tauber-Arons Co., Auctioneers, 341 So. Robertson Blvd., Beverly Hills, Calif. Phone OL 5-9300.

WANTED/FOR SALE

This Tracer Section can be used whenever you are looking for or offering Equipment, Plants, Supplies, Chemicals, Opportunities, Special Services. The rates are low—just call or write Classified Advertising Division, Chemical Week, P.O. Box 12, N. Y. 36, N. Y., Longacre 4-3060.

EQUIPMENT FOR SALE

Reaction kettles—Synthetic Resin—Units 1-18,000 lb. charge stainless with agitator coils condensers, etc. including new "Sela" gas heating unit. 1-18,000 lb. charge stainless with agitator coils, condensers, etc. heated by a "Trent" electric jacket. 1-10,000 lb. charge stainless with agitator coils, condensers, receiver etc. jacketed for "Arochlor" electric heater. All kettles in equal to new condition and being replaced by larger units by new resin manufacturer. FS-5027, Chemical Week.

Pallman Pulverizer: Model RFB. New Condition, with 75 H.P. motor and reduced voltage starter. Liquid Nitrogen Processing Corp., Malvern, Pa., Niagara 4-5200.

Louisville 7' dia. x 70' Long Rotary Cooler, 1/2" welded shell, late model, complete. Perry Equipment Corp., 1415 N. Sixth St., Phila. 22, Pa.

Liquidation, \$8,000,000 Alcohol Plant at Omaha, Nebraska. Dryers, Filters, Still, Evaporators, Exchangers, Tanks, Pumps, etc. Send for circular. Perry, 1415 N. Sixth St., Phila. 22, Pa.

Mikro Pulverizer, #3TH, triple screw feed stirrup hammers, 30 HP TEFC motor. Perry Equipment Corp., 1415 N. 6th St., Phila. 22, Pa.

Copper column, 72" dia. x 46'10" high, 40 trays with bubble caps, design for vacuum. Perry Equipment Corp., 1415 N. 6th St., Phila. 22, Pa.

CHEMICALS FOR SALE

60 Lypks. Aluminum Stearate 32 1/2 lb. Bulk DOS Plast. 32 1/2 lb. (dark). Bulk DRS Plast. 32 1/2 lb. w/w. Bulk Acetone Redistilled 436/2al. Monochlorobenzene, Bulk, 25000# 74/1b. Orthodichloro Benzene, Dra. 4000# 104/1b. FS-5275, Chemical Week.

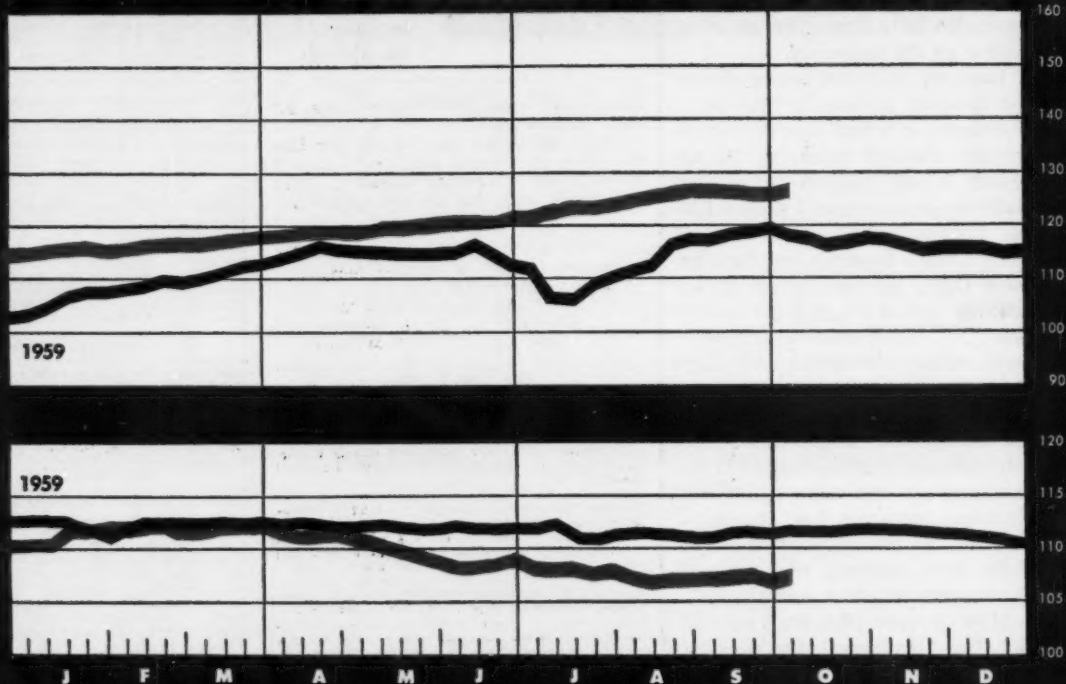
CHEMICALS WANTED

Surplus Wanted—Chemicals, Pharmaceuticals, Oils, Acids, Plasticizers, Resins, Dyas, Solvents, Pigments, Etc. Chemical Service Corporation, 96-02 Beaver Street, New York 5, N. Y. HANover 2-6970.

MISCELLANEOUS

To Employers Who Advertise for Men: The letters you receive in answer to your advertisements are submitted by each of the applicants with the hope of securing the position offered. When there are many applicants it frequently happens that the only letters acknowledged are those of promising candidates. (Others do not receive the slightest indication that their letters have even been received, much less given any consideration.) These men often become discouraged, will not respond to future advertisements and sometimes even question if they are bona fide. We can guarantee that Every Advertisement Printed is Fully Authorized. Now won't you help keep our readers interested in this advertising by acknowledging every application received, even if you only return the letters of unsuccessful applicants to them marked say, "Position filled, thank you." If you don't care to reveal your identity, mail them in plain envelopes. We suggest this in a spirit of helpful co-operation between employers and the men replying to Positions Vacant advertisements. Classified Advertising Division, McGraw-Hill Publishing Company. "Put Yourself in the Place of the Other Fellow."

BUSINESS BENCHMARKS



SEPTEMBER 17, 1960

WEEKLY BUSINESS INDICATORS

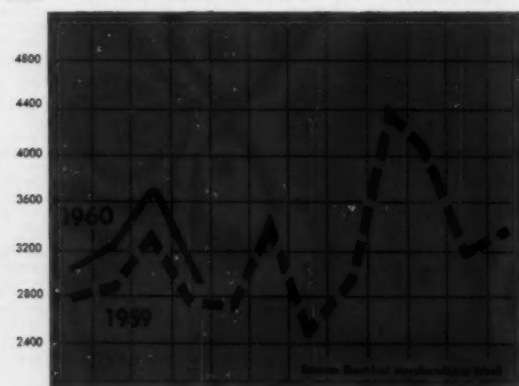
	Latest Week	Preceding Week	Year Ago
Chemical Week output index (1957=100)	124.6	124.0	119.4
Chemical Week wholesale price index (1947=100)	107.0	106.5	110.9
Stock price index (12 firms, Standard & Poor's)	47.24	48.39	57.32
Steel ingot output (thousand tons)	1,441	1,483	327
Electric power (million kilowatt-hours)	14,941	14,602	13,759
Crude oil and condensate (daily av., thousand bbls.)	6,823	6,846	6,784

PRODUCTION INDICATORS 1957=100

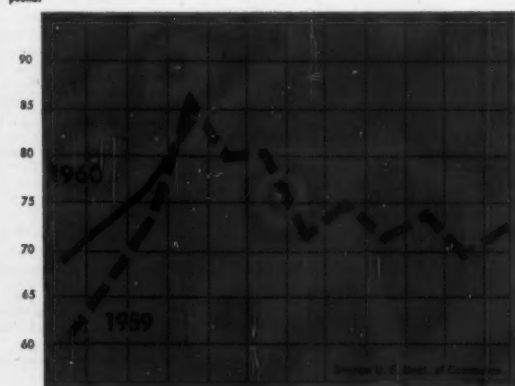
	Latest Month	Preceding Month	Year Ago
All manufacturing	103	110	102
Nondurable goods manufacturing	110	115	106
Durable goods manufacturing	98	106	199
Chemicals and allied products	124.7	123.9	109.8
Industrial chemicals	129.0	128.9	115.9
Petroleum and coal products	111.0	110.1	107.3

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AS ANTICAKING AGENT: add just 0.4% Cab-o-sil, shake — and caky sulfur (left) is transformed into a free-flow powder.



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- **Reinforcing agent** — rubber, silicone, latex film
- **Anticaking agent** — sulfur, insecticides
- **Antislip agent** — solvent-base floor waxes
- **Precoating material** — reproduction paper
- **Low temperature thermal insulation**
- **Pharmaceuticals and Cosmetics** — (See bulletin #cpha-1)

Please send ☐ free Cab-o-sil sample and other technical data checked

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TITLE

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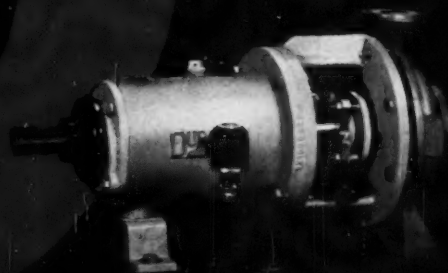
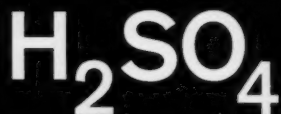
Technical data available:

- () General Properties, Functions and Uses (#cgen-1)
- () Cab-o-sil in the Rubber Industry (#crub-1)
- () Cab-o-sil in Butyl Rubber (#crub-2)
- () Cab-o-sil in Dipped Latex Films (#crub-3)
- () Cab-o-sil in the Lubricating Grease Industry (#cgre-2)
- () Aqueous Dispersions of Cab-o-sil (#cmis-2)
- () A Flatting Agent for Varnishes (#cpai-3)
- () Cab-o-sil in the Reproduction Paper Industry (#cpap-1)
- () Cab-o-sil in the Plastics Industry (#cpia-2)
- () Cab-o-sil in Automobile Polishes (#cpol-1)
- () Cab-o-sil in Pharmaceuticals and Cosmetics (#cpha-1)

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